

STATE WATER RESOURCES CONTROL BOARD
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

Designated March 21, 1974, April 18, 1974, and June 19, 1975

- 1. Pygmy Forest Ecological Staircase**
- 2. Del Mar Landing Ecological Reserve**
- 3. Gerstle Cove**
- 4. Bodega Marine Life Refuge**
- 5. Kelp Beds at Saunders Reef**
- 6. Kelp Beds at Trinidad Head**
- 7. Kings Range National Conservation Area**
- 8. Redwoods National Park**
- 9. James V. Fitzgerald Marine Reserve**
- 10. Farallon Island**
- 11. Duxbury Reef Reserve and Extension**
- 12. Point Reyes Headland Reserve and Extension**
- 13. Double Point**
- 14. Bird Rock**
- 15. Ano Nuevo Point and Island**
- 16. Point Lobos Ecological Reserve**
- 17. San Miguel, Santa Rosa, and Santa Cruz Islands**
- 18. Julia Pfeiffer Burns Underwater Park**
- 19. Pacific Grove Marine Gardens Fish Refuge and Hopkins Marine Life Refuge**
- 20. Ocean Area Surrounding the Mouth of Salmon Creek**
- 21. San Nicolas Island and Begg Rock**
- 22. Santa Barbara Island, Santa Barbara County and Anacapa Island**
- 23. San Clemente Island**
- 24. Mugu Lagoon to Latigo Point**
- 25. Santa Catalina Island - Subarea One, Isthmus Cove to Catalina Head**
- 26. Santa Catalina Island - Subarea Two, North End of Little Harbor to Ben Weston Point**
- 27. Santa Catalina Island - Subarea Three, Farnsworth Bank Ecological Reserve**
- 28. Santa Catalina Island - Subarea Four, Binnacle Rock to Jewfish Point**
- 29. San Diego-La Jolla Ecological Reserve**
- 30. Heisler Park Ecological Reserve**
- 31. San Diego Marine Life Refuge**
- 32. Newport Beach Marine Life Refuge**
- 33. Irvine Coast Marine Life Refuge**
- 34. Carmel Bay**

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

RECONNAISSANCE SURVEY REPORT

FARALLON ISLANDS
SAN FRANCISCO COUNTY

STATE WATER RESOURCES CONTROL BOARD
Division of Planning and Research
Surveillance and Monitoring Section

MAY 1979

WATER QUALITY MONITORING REPORT 79-13

ACKNOWLEDGEMENTS

This State Water Resources Control Board Report is based on a reconnaissance survey report submitted by the Farallon Research Group of the Oceanic Society of San Francisco. The Farallon Research Group acknowledges the individual contributions of:

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The latter report was prepared in fulfillment of an agreement with the California Department of Fish and Game, which has coordinated the preparation of a series of Area of Special Biological Significance Survey Reports for the Board under an Interagency Agreement.

ABSTRACT

Southeast Farallon Island is located at 37°41'57"N latitude and 123°00'02"W longitude offshore of San Francisco Bay. The closest township is Bolinas, Marin County, California, which is 22.8 miles (36.7 km) northeast of the island.

Southeast Farallon Island is 65 acres (26 ha) in area. The total water area within the boundaries of the ASBS is 1885 acres (762 ha).

The Farallon Islands are located near the edge of the continental shelf. From the west, Southeast and Middle Farallons rise steeply from a depth of about 60 fathoms over a distance of 1 to 2 miles, with a maximum water depth of 30 fathoms between them. The North Farallons rise more steeply from a depth of 60 to 80 fathoms over a distance of less than a mile. The subtidal and intertidal substrate is made up of granodiorite and quartz diorite.

The major current systems affecting the Farallon Islands are the California Current and the Davidson Current, both of which are major components of the general northeast Pacific circulation pattern.

The temperature on the islands varies little throughout the year. Rainfall occurs primarily during the winter. The sky is generally clear during the spring and fall; fog prevails during the summer.

The biota of the ASBS are extremely rich and diverse, reflecting the variety of habitat in the area. Important marine organisms identified in the survey were: California mussel, giant green anemone, feather boa algae, elephant seals, California sea lions, harbor seals and Stellar sea lions. The California sea lion is the most numerous of the four mammals on the island.

Recreational activities which take place in the vicinity of the Farallon Islands include: 1) natural history/bird watching tours, 2) sport fishing, 3) skin and SCUBA diving, 4) pleasure sailing, and 5) sail and motorboat racing.

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FINDINGS AND CONCLUSIONS

Preliminary data from the State Mussel Watch Marine Monitoring Program suggests that chlorinated hydrocarbons, petroleum hydrocarbons, and lead concentrations are high at the Farallon Islands.

Several animals on the rare and endangered species list frequent the Farallons and adjacent waters. These animals include: the brown pelican, Pelicanus occidentalis; Peregrine falcon, Falco peregrinus anatum, blue whale, Balaenoptera musculus; fin whale, Balaenoptera physalus; grey whale, Eschrichtius gibbosus; humpback whale, Megaptera movaeangliae; sei whale, Balaenoptera borealis; and the sperm whale, Physeter catodon. These animals are affected either directly or indirectly by the water quality around the ASBS.

A permanent monitoring program for heavy metals, chlorinated hydrocarbons and petroleum hydrocarbons in the water column, sediments, and animal tissues would be required to adequately understand the effects of these pollutants upon the ecology of the ASBS. To be effective, such a monitoring program would need to include close examinations of possible sources, such as shipping and land based municipal and industrial discharges. Ideally, monitoring would be sufficiently intensive to allow comparison of coastal, island and pelagic stations.

INTRODUCTION

The State Water Resources Control Board, under Resolution 74-28 designated certain Areas of Special Biological Significance (ASBS) in the adoption of water quality control plans for the control of wastes discharged to ocean waters. To date, thirty-four coastal and offshore island sites have been designated ASBS. The ASBS are intended to afford special protection to marine life through prohibition of waste discharges within these areas. The concept of "special biological significance" recognizes that certain biological communities, because of their value or fragility, deserve very special protection that consists of preservation and maintenance of natural water quality conditions to practicable extents (from State Water Resources Control Board's and California Regional Water Quality Board's Administrative Procedures, September 24, 1970, Section XI. Miscellaneous--Revision 7, September 1, 1972).

Specifically, the following restrictions apply to ASBS in the implementation of this policy.

1. Discharge of elevated temperature wastes in a manner that would alter natural water quality conditions is prohibited.
2. Discharge of discrete point source sewage or industrial process wastes in a manner that would alter natural water quality conditions is prohibited.
3. Discharge of wastes from nonpoint sources, including but not limited to storm water runoff, silt and urban runoff, will be controlled to the extent practicable. In control programs for wastes from nonpoint sources, Regional Boards will give high priority to areas tributary to ASBS.

4. The Ocean Plan, and hence the designation of Areas of Special Biological Significance, is not applicable to vessel wastes, the control of dredging, or the disposal of dredging spoil.

In order for the State Water Resources Control Board to evaluate the status of protection of the Farallon Islands ASBS, a reconnaissance survey integrating existing information and additional field study was performed by the Farallon Research Group of the Oceanic Society of San Francisco. The survey report was one of a series prepared for the State Board under the direction of the California Department of Fish and Game and provided the information compiled in this document.

ORGANIZATION OF SURVEY

The reconnaissance survey of the Farallon Islands Area of Special Biological Significance employed a number of differing means of investigation. These included a literature review, interviews, a search of records, map reconnaissance, and shoreline observations.

The intertidal regions were assessed by literature review and by active surveys, utilizing the accumulated personal knowledge of the investigators.

Photographs of the shoreline and adjacent land mass were taken and are archived at the State Water Resources Control Board.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

Southeast Farallon Island*, which is included in the boundaries of the City and County of San Francisco, is located at 37°41'57"N latitude and 123°00'02"W longitude. The closest township is Bolinas, Marin County, California, which is 22.8 miles (36.7 km) northwest of the island.

The official boundary description, as stated in the State Water Resources Control Board publication Areas of Special Biological Significance (1976), is as follows:

"Waters within one nautical mile from the Southeast Farallons including Maintop Island, Middle Farallon, the North Farallons, and Noonday Rock."

The rugged coastline of Southeast Farallon Island, excluding the 7 islets, is 4.8 mi. (7.8 km) in perimeter. The island is 65 acres (26 ha) in area. (Huxley, BLM, personal communication). The total water area in the ASBS is 1885 acres (763 ha). There is no surface water on the islands.

*Middle and North Farallon Islands are virtually inaccessible, and therefore could not be measured. Also, no maps or charts were found that were adequate for making accurate measurements of these islands. As little information exists for these islands, much of the information in this report will pertain only to Southeast Farallon Island; Middle and North Farallon Islands are, however, mentioned where information is available.

Nearshore Waters

The major current systems affecting the Farallon Islands are the California Current and the Davidson Current, both of which are major components of the general northeast Pacific circulation pattern. The California Current is the eastern portion of the clockwise circulation of the North Pacific Ocean. This current flows southward from British Columbia to southern California (where it turns southwestward at about 25° N latitude) bringing water which is cooler, less saline and higher in oxygen than the waters further offshore (Reid, Roden and Wyllie, 1958). From February through November the eastern boundary of this current lies close to the coast. In the region of central California the California Current moves at about 0.5 knots and is several hundred kilometers wide, thus encompassing the Farallon Islands during this period. During the same period, a countercurrent flows at depths greater than 650 ft. (200 m) (Reid, Roden and Wyllie, 1958) bringing warmer, more saline waters from the south. From October through April, when the northerly winds are weaker, this countercurrent rises to the surface between the eastern boundary of the California Current and the coast, and is called the Davidson Current. The Davidson Current flows at a rate of 0.5 to 0.9 knots and may be as much as 50 mi. (80 km) wide (Schwartzlose, 1963); therefore, it may encompass the Farallon Islands during late fall and winter.

In addition to the California and Davidson current systems, two other major movements of water may affect the Farallons; however, their effects are less well-known and have not been studied here. These two movements are outflow from the San Francisco Bay estuary system, and upwelling.

The effect of outflow from San Francisco Bay is uncertain, but there are indications that, at least during periods of high discharge, the effects may extend as far as the Farallons. Several workers (Carlson, et al. 1975; Carlson and McCulloch, 1974; Carlson and Harden, 1975) have studied dispersal patterns of suspended particulate matter in San Francisco Bay and the Gulf of the Farallons. Carlson and McCulloch (1974) found

that visible sediment plumes rarely extended more than a few miles seaward from the Golden Gate strait; they also found that even during a winter storm, when the inflow of water to San Francisco Bay was unusually high, the plume at its maximum extended only 19 mi. (30 km) seaward. A less distinct sediment plume adjacent to but separate from the one from San Francisco Bay was observed at one time extending several miles southwest of Southeast Farallon Island. According to Carlson and Harden (1975), satellite imagery generally shows visible plumes extending up to 2 mi. (3 km) offshore and usually within 60 mi. (10 km) of the shoreline. The only data of Carlson and Harden (1975) which include the Farallons show that, from the Golden Gate Bridge to the Farallons, salinity increased from 32.4 o/oo to 34 o/oo. Secchi disc readings increased from 13 ft. (4 m) to 39 ft. (12 m) in August, 1973, a period of relatively low discharge from San Francisco Bay. Flynn (1957) found that the shore station at Southeast Farallon Island recorded an abrupt annual minimum in salinity in March coincident with peak discharge from the San Joaquin and Sacramento Rivers.

The fact that upwelling occurs in the vicinity of the Farallons is evident from the temperature data shown in Fig. 1. In the absence of upwelling, water temperatures begin to rise steeply in May due to increased insolation. Upwelling causes a damping of the temperature increase until later in the summer (usually late July or August). Comparison of temperatures (Fig. 2) obtained near the Farallons (Station 60.60) with those obtained southwest of the Golden Gate (Stations 60.100 and 60.120) show that temperature increases are in fact earlier and larger at the two offshore stations. Winzler and Kelly (1977) state that, in the vicinity of the Farallons, temperature and salinity data indicate that upwelling commences in April-May with maximum surface temperatures of 52.3°-52.5°F (11.3°-11.4°C), peaks in June-July with surface salinities greater than 33.9 o/oo, and subsides by September-October.

Three oceanographic seasons are recognized for ocean waters along the central California coast. Descriptions of the periods and characteristics of these seasons, which were derived primarily from studies in

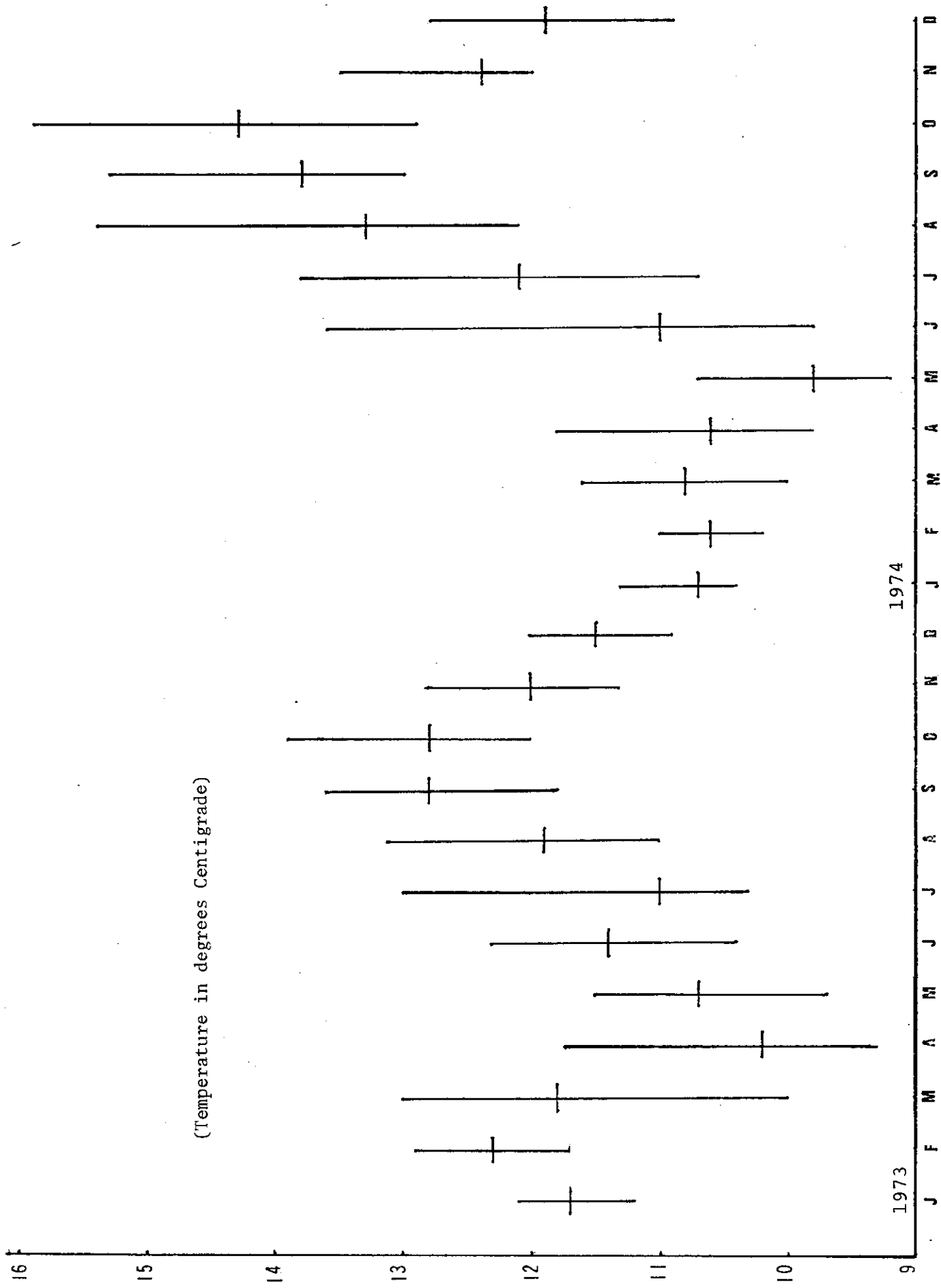


Fig. 1. Surface water temperatures (range and mean) for SE Farallon Island, 1973-1974.

Monterey Bay and are only generally applicable to the Farallons, are summarized from Bolin and Abbott (1963) as follows:

- 1) The beginning of the Davidson Current period (mid-November to mid-February) is the most sharply defined and easily recognized of the three oceanographic seasons as it is characterized by an abrupt decline in surface water temperature. Upwelling ceases as winds become more southerly. The Davidson Current brings oceanic water from the south into the area; thus, surface temperatures are relatively high for winter and after the abrupt drop at the beginning of the season, temperatures decline less than 1.8°F (1°C) per month in Monterey Bay. Surface salinities are low, variable, and declining as this is the season of highest precipitation.
- 2) The Upwelling Period (mid-February to September) begins with intermittent shifts in wind direction from south to northwest, lessening or reversing the northward flow of surface water. By spring, winds are steady from the northwest. During spring and summer the California Current flows southward, and the surface water is carried offshore. Deeper water flows up to replace surface water along the coast. The surface water temperature usually reaches the lowest of the year in April, and by May solar radiation causes the surface water temperature to begin rising. By July the strong northwest winds are decreasing and intermittent, surface temperatures are variable and there may be a pause in upwelling. Over this period, upwelling may occur in one or more pulses due to wind changes.

Increases in salinity during the first half of the upwelling period are due to the cessation of winter storms and the rise of high salinity water from the depths. Salinity reaches its yearly maximum in June or July, then decreases slowly with the subsidence of upwelling.

The northern Gulf of the Farallons is known to be a major area of upwelling (Winzler and Kelly, 1977).

- 3) The Oceanic Period (September to mid-November) is a period of relative calm, with wind stress almost lacking as the north-west winds decrease. Previously elevated cold water sinks and is replaced by a thin layer of warm surface water which is characterized by higher salinity, clear blue color, and zooplankton, typical of oceanic rather than coastal waters.

Although Bolin and Abbott (1963) state that these cyclic changes take place over the entire northeast Pacific and are not unique to Monterey Bay, the Farallon Islands area is sufficiently different from Monterey Bay that some differences in timing and/or intensity of oceanographic seasons may be expected. The greater depth of water, greater distance from a coastline, and lack of submarine canyons (which are known to be major routes for upwelling water) may all result in a damping of features characteristic of the seasons. Also, the Farallons may be affected by the high volume of freshwater discharge from San Francisco Bay during the winter seasons. Conomos, et al. (1970) reported a new bottom current flowing into San Francisco Bay from as far offshore as 13.5 mi. (21.5 km) from Bolinas Point, suggesting that the estuary could induce a shoreward flow of deeper water similar to that of submarine canyons.

At Southeast Farallon Island, the temperature change initiating the Davidson Current Period is not always as clearly defined (Fig. 1) as that reported by Bolin and Abbott (1963). In 1973 the largest drop in mean temperature for a single month was 2.9°F (1.6°C) in March and the next largest was less than 1.8°F (1°C) in December. The drop which should signal the beginning of the Davidson Current Period was also less than 3.4°F (1.9°C) in October, more clearly indicating the beginning of the Davidson Current. Surface salinities are declining over this period (Fig. 3) as is also characteristic of Monterey Bay.

(Salinities in parts per thousand)

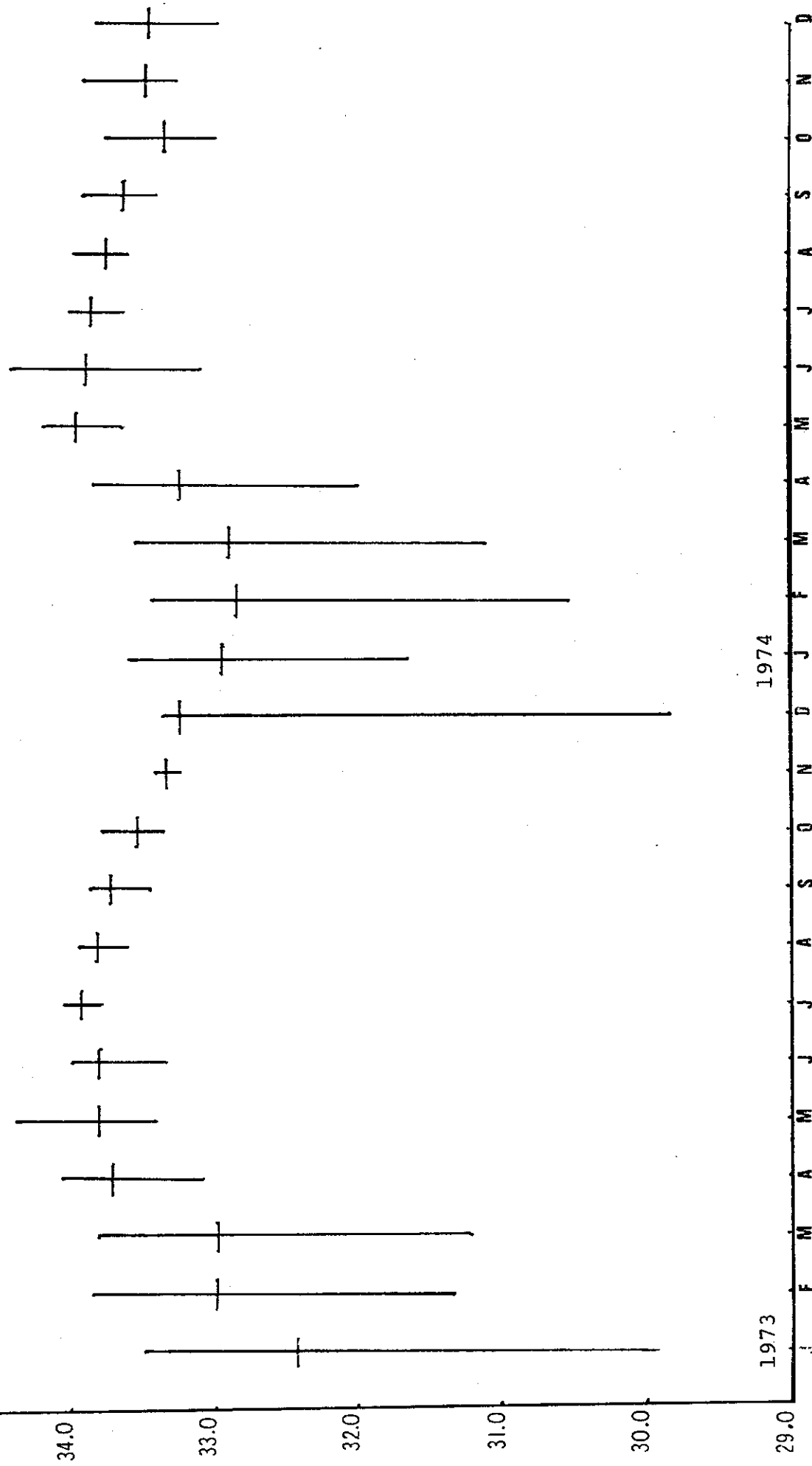


Fig. 3. Surface water salinities (range and mean) for SE Farallon Island, 1973-1974.

Topographic and Geomorphic Characteristics

Submarine Topography: The Farallon Islands are located near the edge of the continental shelf, in a line roughly parallel to the shelf edge. From the west, Southeast Farallon and Middle Farallon rise steeply from a depth of about 60 fathoms (110 m) over a distance of 1 to 2 miles (1.6 to 3.2 km), with a maximum water depth of 30 fathoms (55 m) between them. The North Farallons rise more steeply, from a depth of 60 to 80 fathoms (110 to 146 m) over a distance of less than a mile. Submerged Noonday Rock, the northernmost member of the Farallon group, is located on Fanny Shoal, a bank of 10 to 20 fathoms (18 to 37 m) depth, which is about 1.5 mi. (2.4 km) wide at its maximum dimension. The shoal rises precipitously from a surrounding depth of 60 to 80 fathoms (110 to 146 m).

About 4.5 mi. (7.2 km) southwest of the Farallons, the submarine slope increases abruptly. This is the beginning of the continental slope. Five miles (8 km) southwest of Southeast Farallon Island the ocean floor exceeds depths of 400 fathoms (732 m). The 1000 fathom (1829 m) line is about 15 mi. (24 km) southwest of the islands.

To the east, the Gulf of the Farallons separates the islands from the coast. The depth of the Gulf averages 30 fathoms (55 m) and from this depth the Farallon Islands rise with a slope somewhat less than on the western side.

No major submarine canyons are in the immediate vicinity of the Farallon Islands. The closest such feature is Pioneer Canyon, 20 mi. (32 km) to the south. Cordell Bank, an important fishing ground, lies 17 mi. (27.4 km) northwest of Noonday Rock. (Reference: National Ocean Survey Map 18680.)

Subtidal Geology: The Farallon Islands are high points on a ridge of basement rock at the edge of the continental shelf. The ridge is at least partially granite (granodiorite and quartz diorite) (Hanna, 1951, 1952; Chesterman, 1952; Ross, 1972) and is presumed to be continuous from south of Cape Mendocino to south of Point Piedras Blancas (Curry, 1966).

Cooper (1973) reports a steep, easterly gradient along the landward edge of the ridge near the Farallon Islands as being indicative of faulting, along which uplift occurred in the late-middle Miocene. The sediments of the continental slope west of the Farallon Islands are in part Miocene (Hanna, 1952; Uchupi & Emery, 1963). Sediments east of the Farallon Islands are also Miocene, mostly overlain by a thick section of Pliocene sediments; lower Tertiary rocks underly these in certain sediment-filled troughs. Locally the subtidal substratum is not well known. The bottom, at a depth of 30 to 40 ft. (9 to 12 m) around much of the east side of the island (from Fisherman's Bay to between Mussel Flat and Saddle Rock), is composed of large boulders and pockets of sand (probably derived from granite and shell material). Near East Landing, the substratum consists of sand between ridges of granite.

Intertidal Geology: The intertidal substratum is weathered and deeply fractured granodiorite and quartz diorite as described by Hanna (1951) and by Ross (1972). The rock is composed of feldspar, quartz, biotite, mica, and hornblende and commonly contains crystals as large as 3/8 in. (10 mm) across. Accessory minerals include sphene, zircon and apatite.

The intertidal zone is generally rugged and steep. Around much of the island, a narrow discontinuous shelf exists near sea level. Mussel Flat on the southeast side of the island is a much broader, somewhat higher shelf. Wave-cut surge channels and sea caves extending into the highly jointed and fractured granite rock are a major feature of the intertidal zone on all sides of the island. Some fissures in the rocks are partly filled with a granitic conglomerate (Blankinship, in Blankinship & Keeler, 1892). There is no intertidal sand except at the heads of surge channels and sea caves where coarse sand derived from granite rock and groundup shell material is found with wave-rounded cobbles.

Adjacent land mass: The island itself is also very steep, except for remnants of at least three elevated wave-cut terraces (Hanna, 1952). The most obvious and only extensive terrace is on the south and southeast sides of the island and is about 50 ft. (15 m) above present sea level

The following wind direction and speed data (Table 1) was summarized on a monthly and annual basis. The data was obtained from weather observations taken aboard vessels of various registry. Frequently there is no concrete evidence to prove or disprove the validity of questionable data. Therefore, the accuracy of the data is unknown.

Table 1. Percentage Frequency of Wind Direction by Speed *

Period: (Primary) 1949-1968
(Overall) 1854-1968

Area 025 San Francisco
36-38N Coast-126W

WIN DIR	WIND SPEED (KNOTS)							TOTAL OBS	PCT FREQ	MEAN SPD
	0-3	4-10	11-21	22-33	34-47	48+				
N	.5	3.1	5.6	2.8	.3	*		4453	12.3	16.3
NNE	.2	.8	.9	.2	*	.0		789	2.2	12.9
NE	.2	.8	.4	.1	*	.0		517	1.4	10.2
ENE	.1	.5	.3	*	*	.0		337	.9	9.7
E	.2	.6	.3	*	*	.0		421	1.2	8.4
ESE	.1	.5	.2	*	.0	.0		326	.9	8.5
SE	.3	.9	.6	.2	.1	*		743	2.1	11.6
SSE	.2	1.0	1.1	.4	.1	*		987	2.7	14.3
S	.4	1.9	1.7	.5	.1	.0		1648	4.6	12.5
SSW	.2	1.2	1.0	.2	*	*		965	2.7	11.7
SW	.3	1.8	1.1	.2	*	.0		1225	3.4	10.3
WSW	.3	1.7	.9	.1	*	.0		1086	3.0	9.9
W	.6	3.2	2.0	.3	*	*		2200	6.1	10.3
WNW	.4	3.2	3.4	.7	.1	.0		2787	7.7	12.6
NW	.6	6.0	11.2	4.2	.3	*		8075	22.4	15.7
NNW	.3	4.3	11.8	6.7	.6	*		8552	23.7	17.9
VAR	*	*	.0	.0	.0	.0		11	*	2.5
CALM	2.7							975	2.7	.0
TOT	2718	11387	15372	6002	601	17		36097	100.0	14.2
PCT	7.5	31.5	42.6	16.6	1.7	*		100.0		

* U.S. Naval Weather Service Command: Summary of Synoptic Meteorological Observations, North American Coastal Marine Areas, Vol. 8, May 1970.

BIOLOGICAL DESCRIPTION

Subtidal Biota

Fishes: Follett and Ainley (1976) published the following list of fish which were taken from Pigeon Guillemot nests on Southeast Farallon Island. They reported that the birds do not forage extensively in the intertidal zone.

Chimaeridae

Ratfish, Hydrolagus colliei

Scorpaenidae

Yellowtail rockfish, Sebastes flavidus

Shortbelly rockfish, Sebastes jordani

Black rockfish, Sebastes melanops

Blue rockfish, Sebastes mystinus

Canary rockfish, Sebastes pinniger

Cottidae

Scalyhead sculpin, Artedius harringtoni

Roughback sculpin, Chitonotus pugetensis

Brown Irish lord, Hemilepidotus spinosus

Frogmouth sculpin, Icelinus oculatus

Spotfin sculpin, Icelinus tenuis

Sailfin sculpin, Nautichthys oculofasciatus

Snubnose sculpin, Orthonopias triacis

Darter sculpin, Radulinus boleoides

Grunt sculpin, Rhamphocottus richardsoni

Cabezon, Scorpaenichthys marmoratus

Agonidae

Rockhead, Bothragonus swani

Pygmy poacher, Odontopyxis trispinosa

Bathymasteridae

Ronquils, Rathbunella sp.

Clinidae

Crevice kelpfish, Gibbonsia montereyensis

Cebidichthyidae

New genus, new species

Stichaeidae

Mosshead prickleback, Chirolophus nugator

Pholidae

Red gunnel, Pholis schultzi

Bothidae

Speckled sanddab, Citharichthys stigmaeus

Invertebrates: There is at present no collection of subtidal invertebrates from within the ASBS. Because of the dangerous diving conditions in the area due to a high incidence of shark attacks, no attempt was made to secure specimens for inclusion in this report.

Attached Aquatic Plants: A list of aquatic plants (Appendix 1) was compiled in October 1973 by the Farallon Research Group. The algae were collected in shallow water (0 to 39 ft; 0 to 12 m) in Fisherman's Bay, the north side of Shubrick Point, and between Mussel Flat and Saddle Rock with the aid of SCUBA on October 19 and 20, 1973. Species from the orders of Chlorophyta, Phaeophyta and Rhodophyta are represented.

Intertidal Biota

Intertidal areas of Southeast Farallon Island have certain basic features in common. The intertidal substrate is granodiorite and quartz diorite which is highly fractured, providing many cracks, crevices and surge channels, at the heads of which sand and cobbles occur.

The entire East Landing area is characterized by nearly vertical rock faces on both sides of a long surge channel. At the end of the channel is Garbage Gulch, a sand and gravel beach on which elephant seals frequently haul out. The surge channel faces south-southeast and is usually protected from heavy wave action; waves generally break at the mouth of the channel. On the east side of the surge channel there is a sea cave, the mouth of which is completely submerged except at very low tides.

The eastern side of the peninsula bordering East Landing is almost vertical rock except for a discontinuous shelf at about the +3 to -4 ft. (+0.9 to 1.2 m) tide level. The shelf is about 5 to 6 ft. (1.5 to 1.8 m) wide, with a slope of approximately 20-40°.

Near the southern end of the peninsula is a shallow sea cave (Jewel Cave) with a large tidepool, approximately 6x7x4 ft. (1.8x2.1x1.2 m), in its floor. The tidepool is usually extremely high in diversity of marine invertebrates (e.g. over 20 species of sponges on one wall). There is a surge channel and shelf in front of the cave; California mussel, Mytilus californianus, is predominant on the shelf.

North of Jewel Cave there are many small, exposed tidepools along the shelf. California mussel and coralline algae are dominant and the great green anemone, Anthopleura xanthogrammica, is common in the tidepools. The shoreline is subject to high wave impact even during flat seas, and no turnable rocks occur within this area. There is no shell debris and sand, even in deep tidepools, which confirms observations of heavy wave action.

Mussel Arm is a narrow peninsula (120x38 ft. or 36x12 m) which slopes away from land in both directions. A pair of high intertidal tidepools on Mussel Arm contains the purple sea urchin, Strongylocentrotus purpuratus, ochre seastar, Pisaster ochraceus, solitary California mussels, corallines, a few patches of surfgrass, Phyllospadix torreyi, and red point, Prionitis spp. The larger pool is over 5 ft. (2 m) deep and has large, bare cobbles in the bottom. The red barnacle, Tetraclita squamosa rubescens, occurs on rocks above the water line. A second, smaller pair of tidepools, lower on the peninsula, contain California mussel, the owl limpet, Lottia gigantea, feather boa, Egregia menziesii and iridescent seaweed, Iridaea spp. Both of these sets of tidepools interconnect during rising and falling tides.

The low intertidal zone on the seaward side of Mussel Arm and the shoreline of this area is marked by coralline algae and solitary California mussels. Also in the low intertidal area are feather boa, the brown

out. On this second terrace there are two large, stagnant-looking splash pools. The slope of the intertidal zone is less steep, about 50°, but the flora is similar to those below Shubrick Point.

Most of the area from the east side of North Landing to the north side of Aulon Gulch has been off-limits due to the presence of elephant seals and sea lions. The only area accessible was the North Landing surge channel; the remainder was viewed from a boat moored in Fisherman's Bay.

The surge channel at North Landing consists of a long, wide channel ending in a cobble-boulder beach where elephant seals and sea lions haul out. Sea lions also haul out in large numbers on the east side of the surge channel. On both sides of the channel, the rock rises almost vertically for 10 to 15 ft. (3 to 4.5 m). The channel faces north-northeast and is subject to heavy wave action. The subtidal region here is sand and cobble so the area is scoured. Iridescent seaweed and coralline algae are dominant and other algae occurs, but there are few invertebrates. West of the surge channel, in Fisherman's Bay, the rock forms a very low terrace with sand in the intertidal zone. Intertidal zonation appeared lacking.

Cormorant Cove in Maintop Bay consists of a large, slanting (about 25°), discontinuous rock surface or shelf extending from about -1.5 ft. (-0.5 m) tide level to about +3.0 ft. (+0.9 m). This shelf, as elsewhere on the island, is highly fractured with many cracks and crevices. The cove is open to the northwest and is unprotected by offshore rocks. The rest of this area is steep and inaccessible and is dissected by deep surge channels. The surge channels are rimmed by shelves at approximately the level at which Cladophora and Enteromorpha grow. The portion of the shelf at the extreme southern end of the cove is accessible and bears many tidepools, some deep and many shallow. There were no turnable rocks in the lower tidepools. In the splash zone there are several large stagnant pools with cobble in the bottom.

Algae such as Enteromorpha spp., Cladophora spp. and Porphyra spp., are common on the highest rocks of the shelf, with small amounts of nail brush, Endocladia muricata, in sheltered situations. Two other species of red algae, Iridaea flaccida and Gigartina papillata, are found spottily farther down. The tidepools are lined with encrusting and jointed corallines, Corallina spp. There are clumps of Prionitis lanceolata, P. linearis and Hymenena multiloba. Surfgrass is present on the most exposed lower parts of the shelf. Feather boa is present in slightly more sheltered areas, such as the walls of adjacent surge channels. In the tidepools at about the zero ft. level, small (about 3 in. or; 7.5 cm) purple urchins, sponges and tunicates predominate. In spite of recent storms these pools were not scoured.

The owl limpet and a variety of other limpets are common in upper and middle intertidal regions. Isolated patches of the red barnacle were found in these regions. Among crevices and on the sides of protected rock faces, clusters of goose-neck barnacles, Pollicipes polymerus, were seen. Isolated tidepools often contained a single great green anemone with cottid fishes hiding in the shelter provided by the anemones.

Mussels are scarce in the upper intertidal region, but show a moderate abundance in the lower and middle intertidal regions. An aggregation of cloning anemones line the leeward edge of one of the higher tidepools. Small patches of red sponge and colonial tunicates are present under overhangs.

The middle and lower regions of the cove contain a large number of red algal forms including dense carpets of coralline algae; California mussel becomes evident in this region and species of idoteid isopods were found here.

To the west of Cormorant Cove is a point with a narrow channel separating it from two large offshore rocks (one of the rocks is actually joined to the island by a narrow arch). The rocks provide protection for the point and for a small cove nearby. The area is generally steep, almost vertical rock, but on the west side the rock forms a small shelf.

There are few tidepools here but there are many cracks and crevices. Few conspicuous organisms occur except for discrete patches of red sponge and very abundant coralline algae. On the south side there is one fairly small mussel bed high in the intertidal. Because this area is protected it seems curious that the diversity is so low.

The small cove narrows at its upper end, becoming a high surge channel that passes beneath a natural arch. The channel ends at or above the high water mark in unrounded cobble. The cove contains one large complex of tidepools sheltered by a rocky ridge on their seaward side. Beneath this ridge the pools are fairly deep. In this sheltered situation delicate algae are found; Iridaea cordata, Erythrophyllum delesserioides and Hymenena flabelligera are common. Feather boa is abundant and kelp crabs, Pugettia sp. were observed on the algae. Sponges, tunicates, anemones of various species (Epiactis prolifera, Anthopleura elegantissima, A. xanthogrammica) and cottid fish were also common.

South of this area is Breaker Cove, a very deep channel with absolutely vertical walls which are, in contrast to most of the other intertidal rocky areas, very smooth. The substrate in the channel and on a small beach adjacent to a narrow cave is sand and gravel. The area is well scoured but red sponge is present. In the cave are many large chitons and large gooseneck barnacles but almost no other flora or fauna.

West End, a large islet separated from the main body of the island by Jordan Channel, is usually off-limits; therefore, observations were made by spotting scope from the lighthouse on Tower Peak.

On West End, the northern side of Maintop slopes down to sea level at an angle of about 70°. The shoreline appears to take a great deal of wave shock. Algal zonation in April appears to consist of much young iridescent seaweed and Enteromorpha spp. with corallines and sturdy brown algae predominating below. Many murre and cormorants were observed on the higher rocks during nesting season.

A cove just west of Maintop has two sea caves side by side on the innermost margin. There appears to be sand and/or gravel at the mouths of the caves. Above this is a very broad shelf with little algae.

Further to the west is an even broader shelf which extends into the mouth of Maintop Bay. The shelf, which is well inundated at high tide and exposed to surge at low tide, has a great deal of green algae on the surface. Seagulls and cormorants roost here. Just above the intertidal region is a sandflat with a great deal of driftwood indicating that it may be waveswept in rough weather.

The outermost of the rocks in this cove is similar to Maintop in that its slope is steep and the algal zonation is the same; pelicans are known to roost here.

From Indian Head to the south side of Maintop, the intertidal zone slopes at about 30 to 40°. There is also a sand flat here where elephant seals haul out.

The area just to the west of Jordan Channel has a 30 to 40° slope. Algal zonation is similar to that described for Maintop. Except for some algae, intertidal flora and fauna were not identifiable on West End because of the distance from which observations were made.

On the south side of the island, the intertidal zone south of Falcon's Roost consists of a long slender channel, deep in the middle, with some deep pools and a large mussel bed. Dominant algae on the sides of the channel were corallines, iridescent seaweed, and feather boa. A good number of ochre seastars, not associated with the mussel bed, were seen. A species of red sponge, Ophlitaspongia pennata, was very common. Many small boulders, a few small enough to be turnable, occur. This channel opens to the southeast and does not seem to experience much wave shock. A number of red abalone were seen in the channel.

To the east of Falcon's Roost is a small, very protected cave and channel. Inside the cave, shell debris forms the floor. There is a

hole in the roof of the cave with large quantities of guano on the sides, giving rise to the local name of Funky Arch. Compound ascidians are abundant in the channel in front of the cave. In both the channel and the cave the brown turban snail, Tegula brunnea, is common although they have rarely been seen in other intertidal areas.

The cove between Low Arch and Mussel Flat opens to the south toward Saddle Rock. The marine terrace, which forms much of the south side of the island, slopes steeply and irregularly to the intertidal shelf. The tops of the boulders are covered with Porphyra spp., iridescent seaweed, nail brush, and Enteromorpha spp. The double channel at the western limit of the cove ends in a sandy bottom with a few rocks. Young elephant seals haul out here and many play in the water outside the channel. The mouths of both channels consist of cobbles and sand, the sand extending above the intertidal zone and onto the island, forming Mirounga Beach; this beach is the site of the major elephant seal breeding colony on the island. Large driftwood pieces on Mirounga Beach imply heavy impact from large storm waves.

There are a number of large surge channels in this area, all with steep rocky walls and bottoms of coarse sand, cobble, and some large rocks covered with coralline algae. These surge channels often undercut the rock to form small caves at the backs of the channels. The occasional tidepools contain mostly coralline algae.

One of the largest of the channel caves consists of a narrow channel with a small cave at the back, in its entirety about 50 ft. (15 m) long, with a cobble and sand beach in the cave. The channel and cave contained, at one observation, 20 or more large red urchin, S. franciscanus, apparently loose on the floor as though they had been carried in during a recent storm. The only leather star, Dermasterias imbricata, yet found on the island was observed here. There were many large irregular patches of red sponge.

Just to the east of the channel is a very large sea cave, Low Arch Cave (Fig. 4). The mouth of the cave is somewhat protected by a few

very large boulders. Inside, the floor of the cave is coarse sand and cobble with large rocks. Rough weather occasionally deposits large pieces of driftwood and much drift algae in the back of the cave. The red sponge, Ophlitaspongia, sp. is abundant in the outer portions of the cave and extends in patches about two-thirds of the distance to the back. Under large rocks at the mouth are ophiuroids (brittle stars) and sabellids (plumed worms). Many sea bats, Patiria miniata, (both five and six rayed forms) are common. After a storm, many purple urchins and red urchins were in the cave; they were not noted several days previously.

East of Low Arch Cave the irregular intertidal shelf continues, with tidepools containing coralline algae, large Anthopleura spp. and other anemones, some red and brown algae and vascular surfgrass on outer boulders. The areas between tidepools are covered with young iridescent seaweed, young Enteromorpha muricata and small Gigartina spp., with coralline algae on the lower and outermost regions. Feather boa and some of the other sturdy brown algae occur on the outer edge of this intertidal shelf.

One large surge channel ends directly in front of and about 300 ft. (90 m) south of one of the houses on the island. This channel has 5 to 10 ft. (1.5 to 3.0 m) vertical rock walls, covered with corallines and some brown algae. At the end of this channel are cobbles and a few large boulders. A fair amount of driftwood accumulates in the back of the channel. Sewage from the houses on the island enters the water here. Elephant seals were seen hauling out at the time of observation.

The top of Mussel Flat is irregular at upper tidal levels; it is completely inundated at high tides. Below this, the flat drops almost vertically into two surge channels on the north side and with a somewhat shallower slope on the seaward side. On the top of the flat there are several large tidepools. Several species of sponges are common. Due to the large amount of horizontal relief cut by surge channels, tidepools, and overhangs, the diversity on Mussel Flat is higher than elsewhere on the island. On the island side of the two surge channels, the rock slopes upward from the intertidal region at an angle of about 30° to the

marine terrace. This area is protected from wave shock by the mussel flat. The solitary great green anemone occurs in most tidepools; limpets and mussels predominate and most of the mussel shells bear barnacles and the limpet, Collisella scabra.

The southeast area of the island differs from the Mussel Flat area in being subject to heavier wave shock and in having more fractures or surge channels. The fractures criss-cross through an intertidal shelf in many different directions. The shelf extends outward perhaps 100 ft. (30 m) or more at low tide, rising gently at an angle of about 20 to 30° to a second, broad, flat area.

Those surge channels which are oriented at 90° to the shoreline have cobbles and some gravel at the landward end. Larger rocks and boulders in the channel are covered with upright coralline algae and smaller rocks are covered with encrusting corallines. Surge channels which are subject to reduced wave shock have broad-thallus red algae at the bottom, along with upright corallines.

Tidepools contain coralline algae, both upright and encrusting, as well as many other types of red algae. Some of these pools also contain shell rubble. Most of the shelf area can be termed 'mid-intertidal', with Endocladia muricata, Cladophora spp., iridescent seaweed, California mussels, and goose-neck barnacles predominating.

There are two surge channels which undercut the rock, forming short 'tunnels' along part of their lengths. Both of these end in another undercut portion of rock, forming an overhang or small cave. The walls of both of these channels are for the most part vertical, with a narrow shelf near the bottom of one of them. There are a number of shallow, stagnant pools just above the splash zone. These pools are green with algae and apparently receive an influx of water with only the largest waves and/or the highest tide.

To the east, towards East Landing, tidepools seem to be subjected to more surge. The purple urchin, Strongylocentrotus purpuratus, is

found in most of the pools, and feather boa, Egregia menziesii, becomes more common. The shoreline becomes steeper and more irregular.

See Appendix 2 for a complete species list of invertebrates and attached aquatic plants found in the intertidal region.

Land Vegetation

The terrestrial flora of Southeast Farallon Island consists of about 35 species, of which only 13 are considered native (Coulter, 1972). The flora is composed mostly of annual species which occur on the mainland; there are no species or subspecies unique to the island. Moldenke (1975) reported that 100% of the Farallon flora are capable of self-fertilization, 70% habitually self-fertilize, and 40% are obligate self-fertilizers. He also found 17 species of flower visiting herbivores. Workers previous to Coulter have reported a somewhat smaller flora. Blankinship listed 27 species (10 native and 17 introduced; also listing an additional 6 non-flowering species); Ornduff (1961) found only 20 species (10 native and 10 introduced). The differences in species numbers seem to reflect differing amounts of time available to the collectors. The differences also reflect actual changes in the flora. One native and 8 introduced species have disappeared since 1892; 3 native species have disappeared since 1960. See Table 2. Most of the species lost since 1892 were reported by Blankenship to be confined in a garden which has since been abandoned, leaving the plants easy forage for the rabbits introduced to the island in the nineteenth century. The last of these rabbits was eliminated from the island in 1974. Most of the introduced species have arrived with man's help.

The soil is decomposed granite and guano and is extremely rich in both phosphorous and nitrogen compounds. The activities of nesting sea birds and, until recently, foraging rabbits combined with unique soil conditions severely restrict the composition of the flora (Ornduff, op. cit.; Coulter, 1972).

Table 2. Plant species found on Southeast Farallon Island in 1892 but not in 1960 or 1968 and those found in 1892 and 1960 but not in 1968.

Species found in 1892
but not in 1960 or 1968

Species found in 1892 and
1960 but not in 1968

PTEROPHYTA

ANTHOPHYTA

Polystichum munitum

Juncas bufonius

ANTHOPHYTA

Psilocarphus tenellus var. tenuis

*Avena fatua

Sagina occidentalis

*Cerastium viscosum

*Malva parviflora

*Medicago hispida

*Melilotus indicus

*Polygonum aviculare

*Trifolium bifidum var. decipiens

*Trifolium microcephalum

* Introduced

During the nineteenth and early twentieth centuries, the Farallons were subject to much human disturbance. Sealers exterminated fur seals, elephant seals and sea otters, and hunted sea lions for food during the early 1800's (Scammon, 1974; Ridgell, 1955; Doughty, 1971). A lighthouse was established in 1854 and has been maintained ever since. Throughout most of that time at least four families, with their associated pets and mules, lived on the Farallons year round. In 1854 a commercial egg company began an unregulated harvest of Murre eggs that continued until the turn of the century with apparently little regard for other wildlife. During recent years, the presence of the U.S. Coast Guard, to maintain the navigational aids, has deterred unwanted visitors. In 1969 Southeast Farallon was included in the Farallon National Wildlife Refuge which had been in existence since 1909.

Point Reyes Bird Observatory (PRBO) biologists have been on the island since April 1968. In 1972 when the Coast Guard automated its equipment and left the island, PRBO entered into a cooperative agreement with the U.S. Fish and Wildlife Service to provide a protective "presence" on the island for the Farallon wildlife. Helicopters were found to be very disturbing to the wildlife, causing harbor seals to abandon their hauling out areas and birds to leave their nests. In 1974, at the recommendation of PRBO, the Coast Guard agreed to greatly restrict helicopter use between 15 March and 15 August, when the harbor seals, many of which haul out near the landing pad, are present in greatest numbers. This is also the time when most marine birds are breeding on the island.

Shooting of marine mammals near the island has decreased since PRBO biologists began working on the island. From 1970 to mid-1975 there were 13 instances of shooting at sea lions. Since then, shooting has been confined to seabirds except for one incident of fishermen shooting at sea lions in Fisherman's Bay in the spring of 1977.

There is some disturbance of sea lions on Saddle Rock and at Sea Lion Cove by abalone divers and curious boaters who approach too close to the animals and cause them to go into the water.

Several sites in the vicinity of Southeast Farallon were used for disposal of radioactive waste materials between 1946 and 1966. It was recently discovered that containers holding the waste are ruptured. The effects of this are not yet known although a variety of marine organisms, some of which are in the marine mammal food chain, are to be tested by the Environmental Protection Agency.

Pinnipeds: The highest number of pinnipeds use the island during the spring when the elephant seal females and immatures haul out to molt. California sea lion males haul out briefly while on their southward migration, and Steller sea lions and harbor seals arrive for the breeding season. Pinniped numbers are lowest in the summer when only adult male elephant seals are molting and small breeding populations of the other three species are present.

All pupping, except for elephant seals which breed December to March, occurs in the spring. The California sea lion and northern elephant seal colonies on the Farallons are the northernmost breeding populations for these species; the Steller sea lion, is in the southern end of its range. The pinniped population fluctuates and the number of pups born on the Farallons for the last five years is summarized in Tables 3 and 4.

Steller sea lions, Eumetopias jubatus: The Steller sea lion is found from northern Japan to the Sea of Okhotsk, across the Bering Sea to the Pribilof and Aleutian Islands and down the west coast of North America as far as southern California (Scheffer, 1958). Along the California coast, the adult males are present only during the breeding season, moving northward in winter. Some of the adult females remain at the rookery throughout the year with their pups while others migrate northward in the fall after the breeding season is over. The bulls arrive on the breeding grounds in May in order to set up territories. The cows that have migrated northward return to pup a few weeks after the bulls arrive. Most of the pupping occurs in June and copulation takes place shortly after pupping season. The pups are able to swim soon after birth, and the cows leave them periodically to feed in the

Table 3. Peak number of pinnipeds on Southeast Farallon Island
1972-1977

<u>Year</u>	<u>Eumetopias</u>	<u>Zalophus</u>	<u>Phoca</u>	<u>Mirounga</u>
1972	120	561	5	141
1973	121	196	17	189
1974	261	1403	15	299
1975	176	1374	15	311
1976	187	1163	23	446
1977	246	1593	26	523

Table 4. Pinniped reproduction Southeast Farallon Island
1973-1977 (number of pups born)

<u>Year</u>	<u>Eumetopias</u>	<u>Zalophus</u>	<u>Phoca</u>	<u>Mirounga</u>
1973	9	0	0	2
1974	10	1	1	17
1975	19	1	3	35
1976	14	1	3	60
1977	27	1	3	104

ocean. Some of the young are not weaned until the birth of a pup the following year. The bulls are sexually mature at 5 and the cows at 3 years (King, 1964).

As is true throughout the southern part of its range, the Steller sea lion population on the Farallons is 4 to 6 times lower than it was 40 and 50 years ago (Bonnet, et al., 1938; Bartholomew, 1967; Ainley, et al., 1975). The Southeast Farallon population peaks to as many as 260 animals during April and May when southward migrating animals haul out briefly. The breeding population (present in June and July) appears to have stabilized at about 130 animals (Figure 6). Populations studied in Oregon by Mate (1973) are similar to the Farallon population with a peak of migrating animals before the breeding season. Both these populations differ from the Ano Nuevo population which has peak numbers during the June and July breeding season (Orr and Poulter, 1967; Gentry, 1970). The female to male ratio of 5.1:1 on the Farallons is similar to the 4.3:1 ratio determined by Gentry (1970) for Ano Nuevo Island (Ainley, et al., 1975).

Although the pregnancy rate is low and the pup mortality rate is high (Table 4), the Farallon breeding population has remained consistent since 1974 and appears to have stabilized at about 130 animals. Most of the pup mortality is due to premature births, some occurring as early as February but most of them in April. It is possible that organochlorine pollutants, which are responsible for a high rate of premature pupping in California sea lions from Southern California (Delone, et al., 1973), are also responsible for the premature births in Steller sea lions on the Farallons (Ainley, et al., 1975). The Farallon rate of premature births is nearly 10 times higher than the 4% found by Mate (1973) in Oregon (Table 5). In years of severe storms, such as 1975, pup mortality is increased (Table 5).

Both California and Steller sea lions tend to congregate on the windward side of the island (Figure 8) with Steller sea lions in the more exposed areas including Saddle Rock. Sea lions are also found on the rocks of the North Farallons, 7 mi. (11 km) to the north. It is

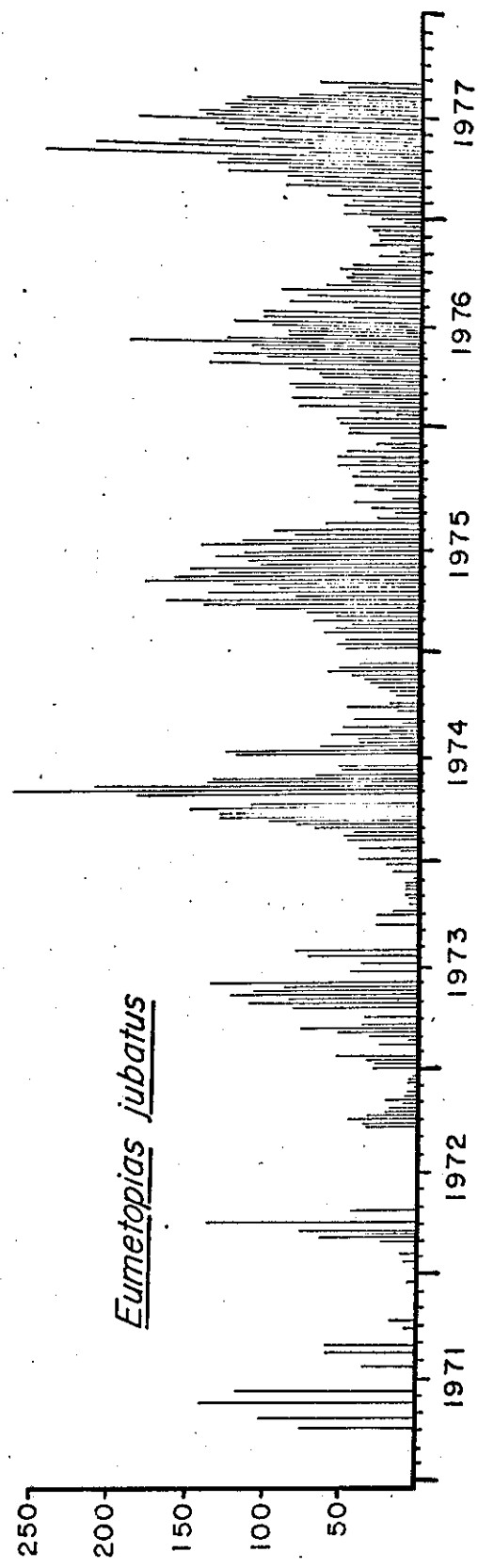


Figure 6. The annual fluctuations in numbers of Eumetopias at the Farallons 1971-1977.

Table 5. Reproductive success of female Eumetopias on Southeast Farallon Island 1973-1977

<u>Year</u>	<u># ♀♀ present</u>	<u># pups born</u>	<u>% pregnancy</u>	<u># premature & still births</u>	<u>pup deaths other causes</u>	<u>% mortality</u>
1973	73	9	12	3	--	33
1974	110	10	9	4	--	40
1975	98	19	19	4	5	47
1976	98	14	14	5	1	43
1977	111	27	24	11	--	41

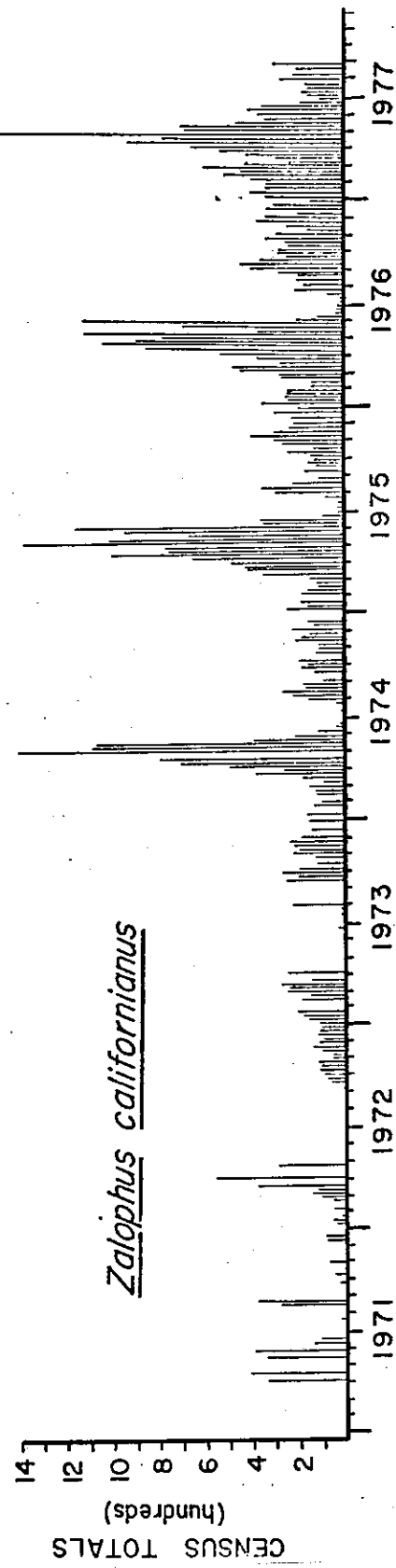


Figure 7. The annual fluctuations in numbers of Zalophus at the Farallons 1971-1977.

The California sea lion, like the Steller sea lion, tends to concentrate on the windward side of the island (Figure 8). However, the California sea lion is found in the more sheltered areas of Sea Lion Cove and in Fisherman's Bay and are observed higher up on the rocks.

Northern Fur Seal, Callorhinus ursinus: In North America the northern fur seal breeds almost exclusively on the Pribilof Islands, Alaska. After the breeding season, mainly immature animals and adult females migrate south through California waters, 10 to 91 mi. (16 to 145 km) offshore, while most of the adult bulls remain in the Gulf of Alaska. Small breeding populations have begun recently on Castle Rock and San Miguel Island in southern California (Peterson, et al., 1968).

Fur seals probably bred on the Farallons before the sealers of the nineteenth century exterminated them. From 1970 to 1976, single fur seals were seen every other year hauled out on Southeast Farallon. In 1977 two fur seals were seen in July and August, most probably different individuals. All the fur seals observed on Southeast Farallon have been female or immature animals and all but one were seen in Sea Lion Cove near California or Steller sea lions. Fur seals are much more common near the North Farallons, 7 mi. (11 km) to the north; on boat trips between the two groups of islands, 1 to 12 fur seals were seen in the water in 1977.

In December 1977 a fur seal pup from San Miguel Island was released in Fisherman's Bay by the Department of Fish and Game after rehabilitation. It was not seen again.

The stomachs of fur seal carcasses from north central California were examined and found to contain anchovies and cephalopods.

Harbor seal, Phoca vitulina: The eastern Pacific subspecies of the harbor seal, Phoca vitulina richardi, is found along the North American coast from Alaska to Baja California (King, 1964). Migratory movement among the population is local with numbers building up at the rookeries during the peak of pupping and breeding; the timing of the pupping and

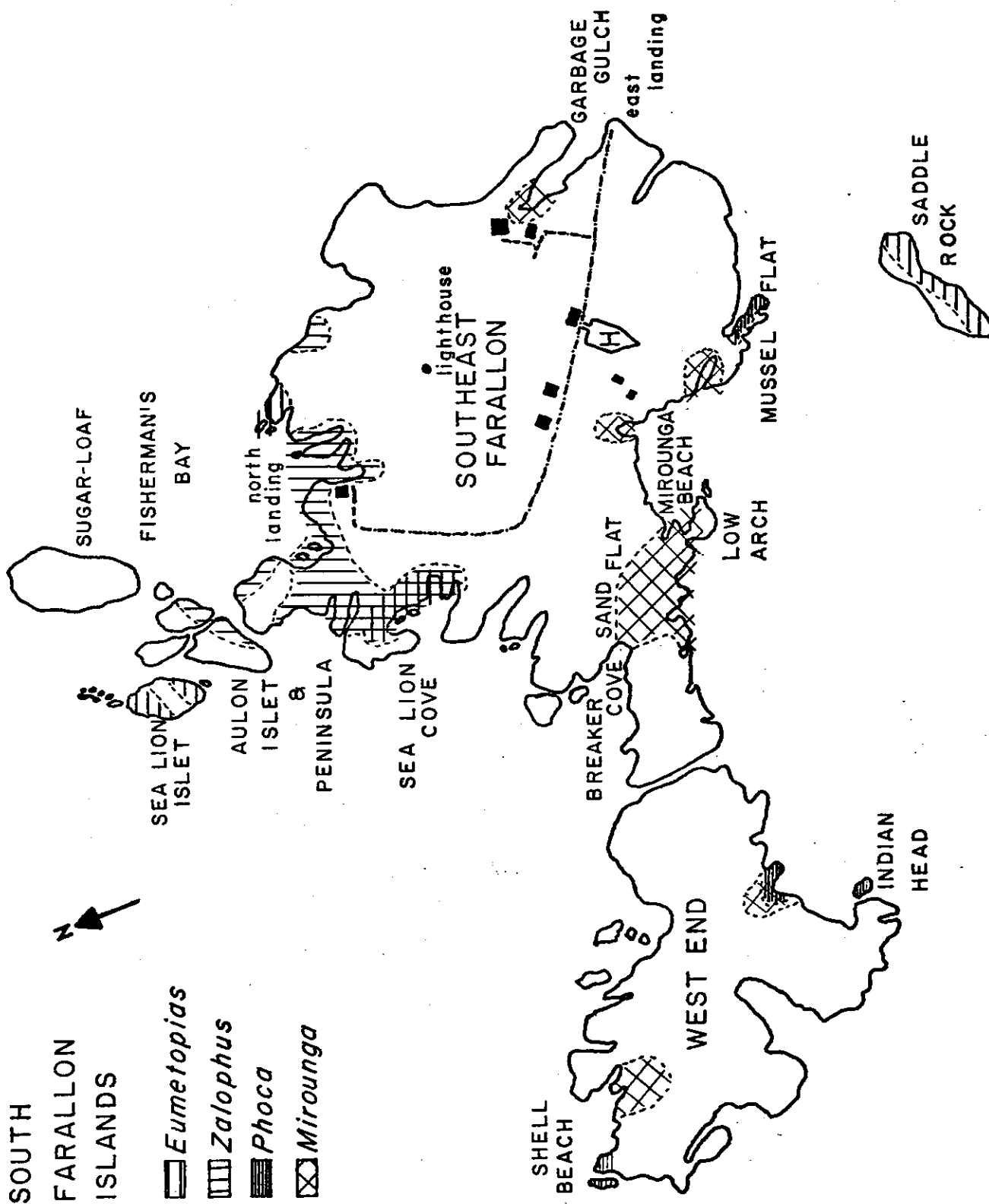


Figure 8. The South Farallon Islands showing the usual areas where various pinnipeds haul out.

breeding season varies according to latitude. For harbor seals on the Point Reyes peninsula, where the population is about 1,000 animals, pupping occurs from late March to early June. After 6 to 8 weeks the pups are weaned and the adults begin molting in late June and July. In August, mating occurs at the rookeries; during the fall and winter, the animals disperse to other areas (Sarah Allen, pers. comm.).

Early reports of Farallon wildlife mention harbor seals only briefly as occasional winter residents (Gruber, 1884; Blankinship and Keeler, 1892; Ray, 1934). This pattern of the harbor seal as a winter resident continued during the early years of observation of PRBO biologists (1968-1972). However, during 1973 the number of sightings, and the number of animals seen, increased (17 were observed in March) and for the first time animals were observed during the summer breeding season (Figure 9). It was not until the following year that the first pup recorded for the Farallons was born (Ainley, et al., 1975). Since then, 3 pups have been observed each year and the population has slowly increased. In 1977, 26 harbor seals were seen.

Harbor seals are found in three major areas on the island: Mussel Flat, Indian Head Beach and Shell Beach (Figure 8). The number of animals observed on Shell Beach seems to be increasing and it appears to be the most likely spot for pupping to occur because it is slightly more protected from high seas and swells.

Although the population is still small, Southeast Farallon Island is an important area for the seals as it is undisturbed by people or dogs. Human disturbance of the mainland rookeries may be one reason breeding on the Farallons began.

Stomachs of harbor seals washed ashore in north central California contained evidence of embiotocids, eelpout, cephalopods, greenling, flatfish, tomcod, rockfish, hake and hagfish.

Northern elephant seal, Mirounga angustirostris: In the early 1880's the northern elephant seal was breeding from the Point

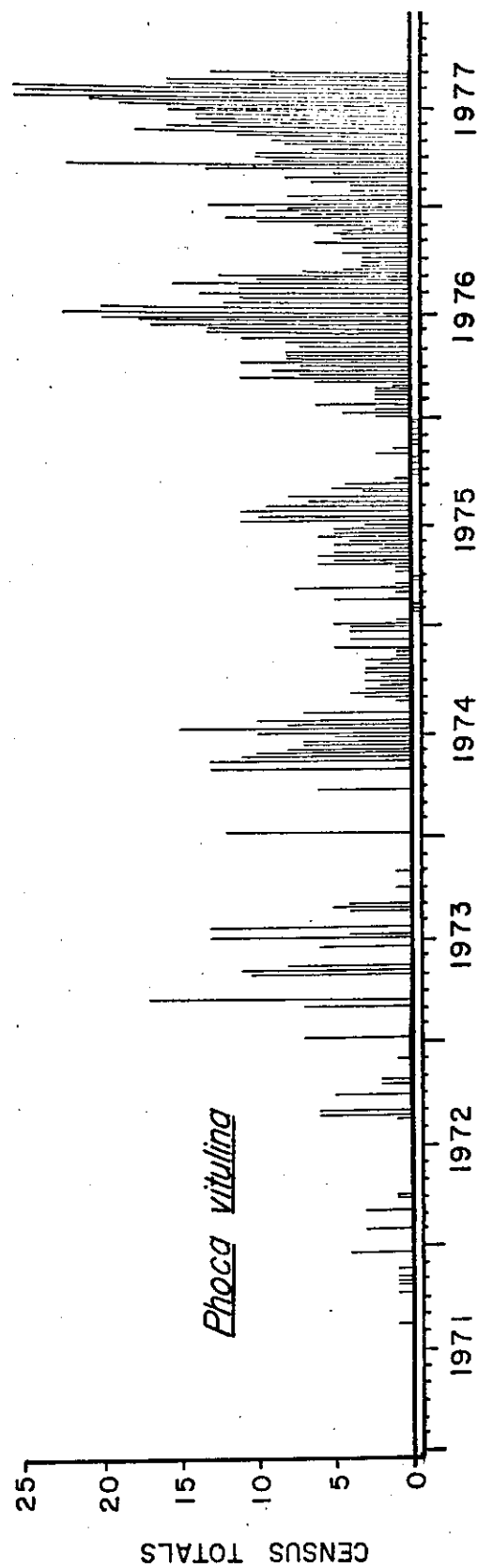


Figure 9. The annual fluctuations in numbers of Phoca hauled out at the Farallons 1971-1977.

Reyes peninsula in northern California to the islands off central Baja California. Seal hunters in the nineteenth century reduced the population to less than 100 animals at the turn of the century (Bartholomew & Hubbs), 1960). Since the 1920's, under protection from the Mexican and U.S. governments, the elephant seal has recolonized its former range and even expanded to the mainland at Ano Nuevo Point. The population now stands at about 50,000 (LeBoeuf, 1977).

The first elephant seal seen on the Farallons after a lapse of more than 150 years was an immature female in 1959 (Thoresen, 1959). Thirteen years later, breeding began with the birth of a single pup. The breeding population has steadily increased; 104 pups were born in 1977 and 523 animals were recorded at the spring peak in 1977.

Some elephant seals are seen on the island throughout the year (Figure 10) but the population structure changes with the seasons. Breeding season begins in December with the arrival of the bulls and continues as cows stagger their arrival between late December and early February. The bulls leave in mid-March, a few days after the last cow departs. Most of the pups remain on the island until April teaching themselves to fish and swim. The spring molt of females and immature animals begins in April and there is a peak of animals in late May. The adult bulls molt in August. In October a fall peak of yearlings and other immature animals occurs. At the Farallons this peak nearly reaches the height of the spring peak; at other rookeries the spring peak is much higher than the fall peak.

Sightings of animals tagged as pups on the Farallons indicates that the young travel as far south as San Miguel Island, California, and as far north as Cape Arago, Oregon.

A summary of pup mortality from 1972-1977 appears in Table 7. The mortality rate has fluctuated considerably - from 7 to 71%. The extremely high mortality of 71% occurred because all but two of the cows pupped on one small beach. This beach was strongly affected by storms and high tides which radically increased the density of the beach. In the resulting

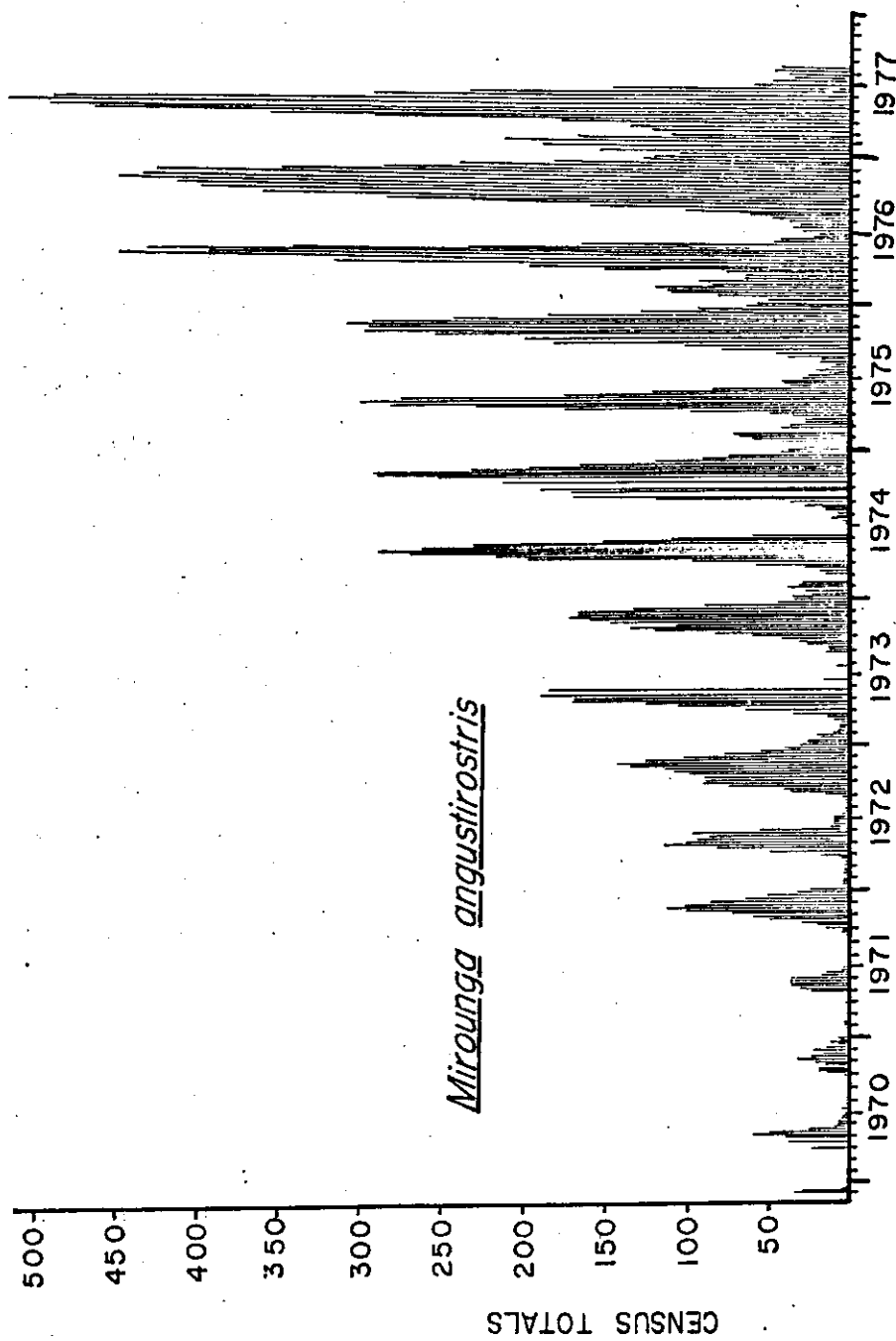


Figure 10. Numbers of Mirounga at the Farallons 1970-1977.

Table 7. Pup mortality for Mirounga on Southeast Farallon Island 1974-77 -- causes of death.

<u>Year</u>	<u># pups born</u>	<u># pups died</u>	<u>% mortality</u>	<u>separated from cow</u>	<u>washed away by storms</u>	<u>crushed by bull</u>	<u>stillborn</u>	<u>other</u>
1974	17	12	71	8	2		1	1
1975	35	7	20		3	2	1	1
1976	60	4	7	1	1	1	1	
1977	104	20	19	7	6	5	2	
				<u>16</u>	<u>12</u>	<u>8</u>	<u>5</u>	<u>2</u>

Table 8. Elephant Seal Pup Survival 1974-1976

	1974 n=17		1975 n=35		1976 n=60		TOTAL n=113	
	#	%	#	%	#	%	#	%
Pups surviving to weaning (first spring	5	29%	28	80%	56	93%	89	78%
First fall	3	18%	11	31%	22	37%	36	32%
Second spring	3	18%	10	29%	17	28%	30	26%
Second fall	3	18%	9	26%				
Third spring	3	18%	7	20%				
Third fall	2	12%						
Fourth spring	2	12%						

carcharias, although the stomach of a blue shark, Pironace glauca, collected 0.6 mi. (1 km) from the island contained half of a harbor seal.

Killer whales, which are periodically seen in the vicinity of the island, are probably also predators of the Farallon pinniped population. The only attack, seen from the island, by a killer whale on a marine mammal was on a gray whale. It appeared to be unsuccessful.

Cetaceans: Ten species of cetaceans have been seen in the waters around the Farallons since PRBO biologists began observing in 1970. Some are seen regularly and others are seen less frequently. Those seen most often are gray, humpback and killer whales.

Gray whales, Eschrichtius robustus: Gray whales are seen each year from late November until June or July and occasionally into August. The largest numbers are seen during December and early January while the grays are on their southerly migration to breeding grounds in Baja California. Grays are also seen on their return migration to the arctic feeding grounds in the spring. The whales then often spend several days feeding around the island and some recognizable individuals even summer near the Farallons (Ainley, et al., 1975).

Humpback whales, Megaptera novaeangliae: These whales are seen regularly in the late summer and early fall during their southward migration. In 1977, for the first time, a cow and her calf were seen in the spring (Ainley, et al., 1977).

Killer whales, Orcinus orca: The killer whales have been seen between mid-April and early December, often in pods of 6 or 7 and mainly in a family unit including a bull, cow and calf.

Other cetaceans seen from Southeast Farallon include the finback whale, Balaenoptera physalus, sei whale, Balaenoptera borealis, sperm whale, Physeter catodon, Minke whale, Balaenoptera acutorostrata, and Dall's porpoise, Phocoenoides dalli. A dead Risso's dolphin, Grampus

griseus, washed ashore in 1973. A single blue whale, Balaenoptera musculus was seen near the North Farallons in 1976.

Unique Components

The most unique component of the Farallons ASBS is the abundance of bird and marine mammal wildlife. It is this abundance of wildlife that has so affected the history of the Farallons, and it is this abundance which makes the Farallons a priceless California resource.

LAND AND WATER USE DESCRIPTION

Marine Resource Harvesting

Commercial Fishing: The commercial trawling efforts within the ASBS boundaries are limited and of little consequence. Most of the trawling around the Farallon Islands occurs outside the ASBS boundaries at the 40 fathom and 80 fathom contours. Two species of rockfish, Sebastes goodei and Sebastes paucispinis, represent the largest portion of the catch at the 80 fathom contour, while several species of flounder Parophrys vetulus, Psettichthys melanostictus, Glyptocephalus zachirus and Eopsetta jordani compose the bulk of the catch at the 40 fathom contour.*

Commercial salmon fishing represents a major activity around the Farallon Islands. Most of the fishing occurs in the months of June, July and August. Some of the largest king salmon caught in California come from the waters around the Farallon Islands.**

It was not possible to accurately estimate the actual fishing effort within the ASBS boundaries; however, the Farallon Islands continue to be a major resource for commercial salmon fishing in central California.

Sport Fishing: Most sport fishing around the Farallon Islands occurs within the boundaries of the ASBS. Lingcod, Ophiodon elongatus, cabezon, Scorpaenichthys marmoratus, and several species of rockfish are the predominate species included in the sport fishing catch within the ASBS. Detailed accounts of the sport fishing catches for the years 1974-1976 are given in Tables 9 to 11.

* Tom Jow, DF&G, personal communication.

** Karen Sjogren, DF&G, personal communication.

Table 9. Sport Fishing Catch Data 1974*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	1,549	138	546.0	6
02	7,683	918	4,102.5	78
03	6,101	915	4,004.0	48
04	7,170	1,442	6,190.5	108
05	12,037	4,506	20,055.4	368
06	18,928	5,212	23,345.0	398
07	19,481	3,642	15,277.5	259
08	22,230	1,652	6,145.5	62
09	25,834	1,826	7,599.5	69
10	29,899	2,090	7,539.5	79
11	19,927	1,463	5,098.5	60
12	10,850	796	2,616.5	39
Totals	181,689	24,610	102,518.4	1,542

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Pacific Mackerel	07	4	48
	08	16	
	09	25	
	10	3	
Jack Mackerel	07	468	1,215
	08	510	
	09	188	
	10	46	
	11	3	
Blue Shark	07	33	36
	08	3	
Jack Smelt	04	1	1

*Leo Pinkas, DF&G, personal communication.

**Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Lingcod***	01	175	
	02	490	
	03	233	
	04	284	
	05	106	
	06	296	
	07	370	
	08	692	
	09	1,720	
	10	1,353	
	11	820	
	12	<u>505</u>	7,044
California Halibut	06	6	
	07	4	
	09	2	
	10	<u>1</u>	13
Sanddab	05	8	
	06	22	
	07	<u>40</u>	70
Flounder	01	30	
	02	30	
	03	8	
	04	17	
	05	5	
	06	48	
	07	26	
	08	89	
	09	186	
	10	30	
	11	44	
	12	<u>42</u>	555
Rockfish***	01	4	
	02	30	
	03	4,504	
	04	5,890	
	05	5,563	
	06	11,027	
	07	14,603	
	08	20,798	
	09	23,660	
	10	28,388	
	11	19,302	
	12	<u>10,302</u>	151,227

* **Abundantly caught within ASBS

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Cabezon***	01	4	
	02	30	
	03	12	
	04	3	
	05	10	
	06	36	
	07	35	
	08	36	
	09	48	
	10	26	
	11	1	
	12	<u>1</u>	242
Kelp Greenling** *	03	1	
	04	3	
	05	2	
	06	2	
	07	1	
	09	<u>1</u>	10
Salmon	02	1,005	
	03	1,338	
	04	963	
	05	6,288	
	06	7,425	
	07	3,887	
	08	85	
	09	4	
	10	52	
	11	<u>37</u>	21,084
King Salmon	04	8	
	05	2	
	06	<u>31</u>	41
Silver Salmon	04	1	
	05	45	
	06	<u>24</u>	70
Steelhead	06	<u>1</u>	1
Striped Bass	07	<u>4</u>	4
White Croaker	03	5	
	07	<u>6</u>	11

***Abundantly caught in ASBS

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Wolf-Eel	05	<u>2</u>	2
Ocean Whitefish	08	<u>1</u>	1
Pacific Hake	05	6	12
	06	<u>6</u>	
Octopus	06	<u>2</u>	2

Table 10. Sport Fishing Catch Data 1975*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	11,950	796	2,493.5	32
02	11,560	1,157	4,572.5	56
03	13,648	1,251	4,501.5	65
04	14,760	4,781	20,747.6	371
05	16,454	4,293	18,625.3	336
06	18,347	2,680	11,010.0	165
07	26,125	6,033	26,113.2	450
08	24,818	3,421	14,448.0	204
09	24,041	1,904	7,869.5	79
10	12,681	1,303	5,528.5	66
11	4,440	706	3,221.0	37
12	824	99	510.0	6
Totals	178,648	28,422	119,640.8	1,867

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Pacific Mackerel	07	2	3
	10	<u>1</u>	
Jack Mackerel	07	38	791
	08	165	
	09	382	
	10	<u>206</u>	
Blue Shark	07	<u>2</u>	2

*Leo Pinkas, DF&G, personal communication.

** Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 10. Sport Fishing Catch Data 1975 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Ling Cod***	01	871	
	02	580	
	03	326	
	04	287	
	05	355	
	06	693	
	07	332	
	08	901	
	09	2,080	
	10	511	
	11	327	
	12	<u>58</u>	7,341
California Halibut	02	1	
	04	1	
	07	2	
	08	<u>2</u>	6
Sanddab	03	7	
	06	4	
	09	<u>8</u>	19
Flounder	02	15	
	03	7	
	04	46	
	05	55	
	06	19	
	07	48	
	08	135	
	09	31	
	10	40	
	11	46	
	12	<u>25</u>	467
Rockfish***	01	11,079	
	02	10,283	
	03	13,087	
	04	8,428	
	05	11,386	
	06	16,548	
	07	21,023	
	08	22,000	
	09	21,277	
	10	11,648	
	11	3,935	
	12	<u>741</u>	151,435

***Abundantly caught in ASBS

Table 10. Sport Fishing Catch Data 1975 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Cabezon***	04	11	70
	05	21	
	06	3	
	07	10	
	08	7	
	09	13	
	10	<u>5</u>	
Kelp Greenling***	04	2	4
	05	1	
	06	<u>1</u>	
Salmon	02	681	18,381
	03	219	
	04	4,982	
	05	4,626	
	06	1,065	
	07	4,660	
	08	1,604	
	09	235	
	10	178	
	11	<u>131</u>	
King Salmon	05	<u>1</u>	1
Silver Salmon	05	<u>9</u>	9
Steelhead	07	<u>2</u>	2
Striped Bass	06	2	108
	07	6	
	08	8	
	09	1	
	10	<u>59</u>	
White Croaker	06	12	12
Wolf Eel	03	1	2
	11	<u>1</u>	
Pacific Hake	07	<u>1</u>	1
Miscellaneous Fish	03	1	4
	04	<u>3</u>	

***Abundantly caught in ASBS

Table 11. Sport Fishing Catch Data 1976*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	3,733	304	1,137.0	17
02	5,176	753	3,177.5	44
03	16,797	1,535	6,244.0	80
04	18,722	3,015	13,481.5	231
05	19,373	4,889	22,428.7	386
06	22,722	3,908	18,491.2	279
07	23,925	2,143	9,546.0	100
08	19,275	1,704	8,017.0	68
09	23,074	1,861	7,709.5	79
10	27,796	2,335	10,214.5	103
11	14,672	1,227	5,051.0	58
12	12,117	835	2,935.0	35
Totals	207,382	24,509	108,432.9	1,480

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Albacore	08	<u>2</u>	2
Pacific Mackerel	08	10	63
	09	<u>53</u>	
Jack Mackerel	06	2	367
	07	78	
	08	183	
	09	97	
	10	<u>7</u>	
Shark	01	<u>1</u>	1
Bonito Shark	10	<u>1</u>	1

*Leo Pinkas, DF&G, personal communication.

** Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Blue Shark	06	1	59
	07	15	
	08	11	
	09	30	
	10	<u>2</u>	
Ling Cod***	01	138	8,983
	02	382	
	03	572	
	04	382	
	05	241	
	06	420	
	07	1,083	
	08	972	
	09	1,333	
	10	1,782	
	11	807	
	12	<u>871</u>	
California Halibut	04	2	6
	08	1	
	09	1	
	10	<u>2</u>	
Sanddab	03	1	29
	06	7	
	10	<u>21</u>	
Flounder	01	46	552
	02	19	
	03	161	
	04	56	
	05	1	
	07	117	
	08	31	
	09	56	
	10	5	
	11	20	
	12	<u>15</u>	
Rockfish***	01	3,543	
	02	4,697	
	03	15,886	
	04	15,559	
	05	10,514	
	06	18,081	

*** Abundantly caught within ASBS

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Rockfish*** (cont'd)	07	22,224	180,378
	08	17,891	
	09	21,327	
	10	25,687	
	11	13,742	
	12	<u>11,229</u>	
Cabezon***	01	3	141
	02	6	
	03	30	
	04	21	
	05	61	
	06	1	
	07	1	
	08	4	
	09	9	
	10	4	
	12	<u>1</u>	
Kelp Greenling***	07	5	6
	08	<u>1</u>	
Salmon	01	2	16,143
	02	74	
	03	147	
	04	2,702	
	05	8,502	
	06	4,089	
	07	392	
	08	165	
	09	24	
	10	<u>46</u>	
Striped Bass	07	10	42
	08	3	
	09	22	
	10	<u>7</u>	

***Abundantly caught within ASBS

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
White Seabass	10	<u>9</u>	9
Opah	11	<u>1</u>	1
Pacific Hake	06	<u>25</u>	25
Octopus	12	<u>1</u>	1

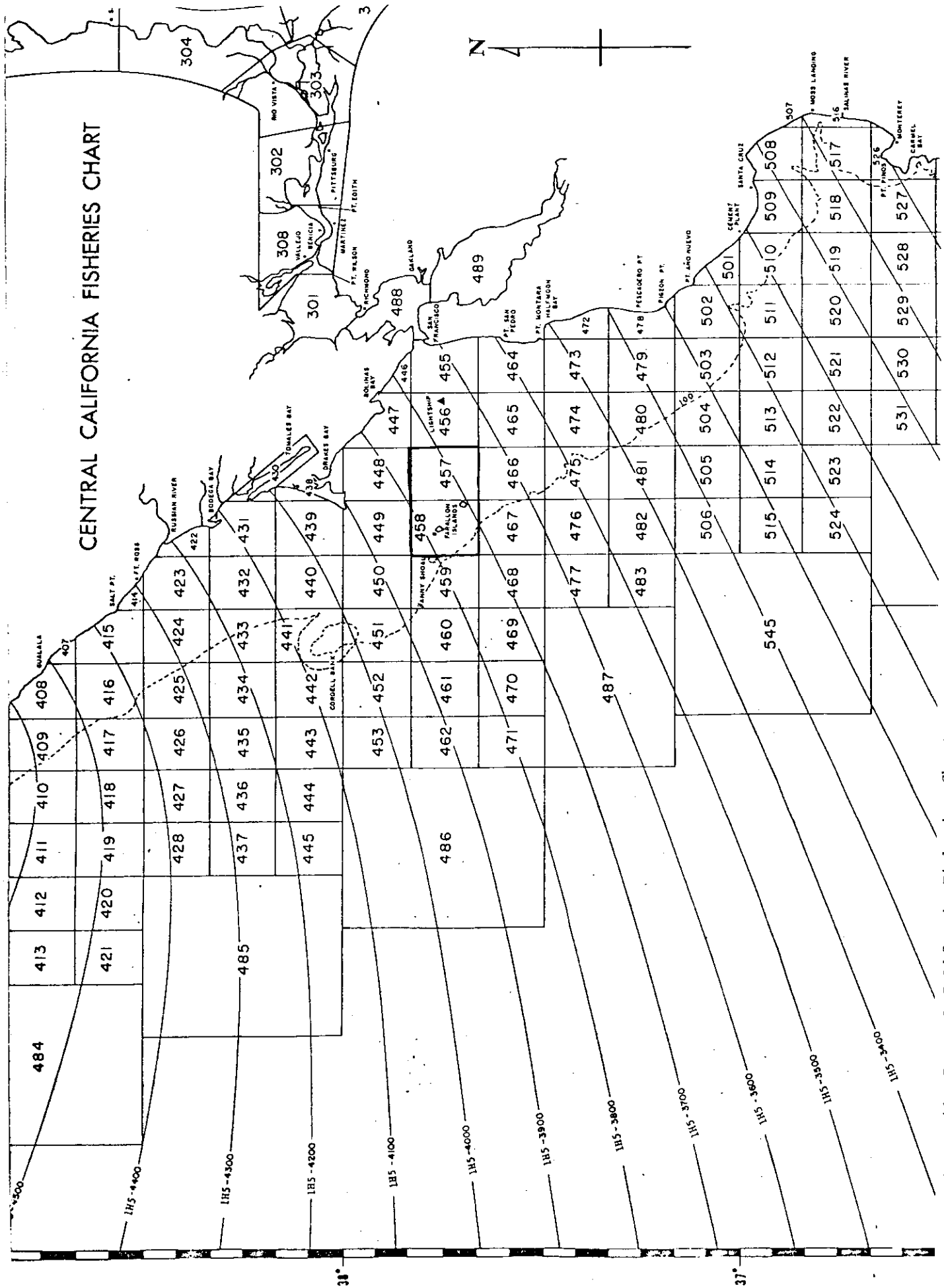


Figure 11. Central California Fisheries Chart

Sport fishing activities at the Farallon Islands occur year round; however, there is a decreased bottom fishing effort during the summer months when the sport fishermen concentrate on salmon and albacore. Most of the salmon and albacore are caught outside the ASBS boundaries.***

Municipal and Industrial Activities

Power generation for the Farallons is confined to Southeast Farallon Island and is accomplished by means of diesel fueled generators for the lighthouse and for the two houses.

Governmental Designated Open Space

The Farallon National Wildlife Refuge consists of Southeast, Middle, and North Farallons, submerged Noonday Rock, and surrounding waters. Established by Executive Order in 1909, the Farallon Reservation included only Middle and North Farallons, and Noonday Rock. Southeast Farallon Island was added by Public Land Order in 1969. In 1974 the Farallon Wilderness was established to include Noonday Rock, Middle and North Farallons, and the West End of Southeast Farallon.

The Fish and Wildlife Service of the United States Department of the Interior has jurisdiction over the land area of the refuge to the high tide mark. From the high tide mark to 1,000 yards (914 m) offshore is controlled by the California Department of Fish and Game. Other agencies having jurisdiction over the islands include the City and County of San Francisco and the United States Coast Guard. All waters within 1 mi. (1.6 km) of the Farallon Islands are included in a California State Bird Refuge. The State Water Resources Control Board has designated the nearshore waters of the Farallon Islands an Area of Special Biological Significance.

*** Jack Baxter, DF&G, personal communication.

Survey has maintained a seismograph on the island since 1974. Injured or sick pinnipeds are often released at the Farallon Islands after treatment by the Marine Mammal Center in Marin County.

Transportation Corridors

There are no transportation corridors on the island, or within 1 mi. (1.6 km) radius designated for this study. Travel on the island is by foot, and transportation of materials (food, personal effects, etc.) is by push-cart. Boats call at the island once or twice a week and sometimes less. These boats approach from the east and moor at buoys in East Landing or Fisherman's Bay.

The nearest designated transportation corridors are two major shipping channels for vessels (300 gross tons and over) destined for San Francisco Bay. The northwestern limit of the Main Traffic Lane is 2.6 mi. (4.2 km) south of Southeast Farallon Island and the southwestern limit of the Northern Traffic Lane is 8.7 mi. (14 km) north of Middle Farallon (Figure 12); these are the closest distances between corridors and islands. Vessels not calling at San Francisco Bay pass west of the Farallons within designated lanes except when they travel direct between Point Arguello and Point Arena.

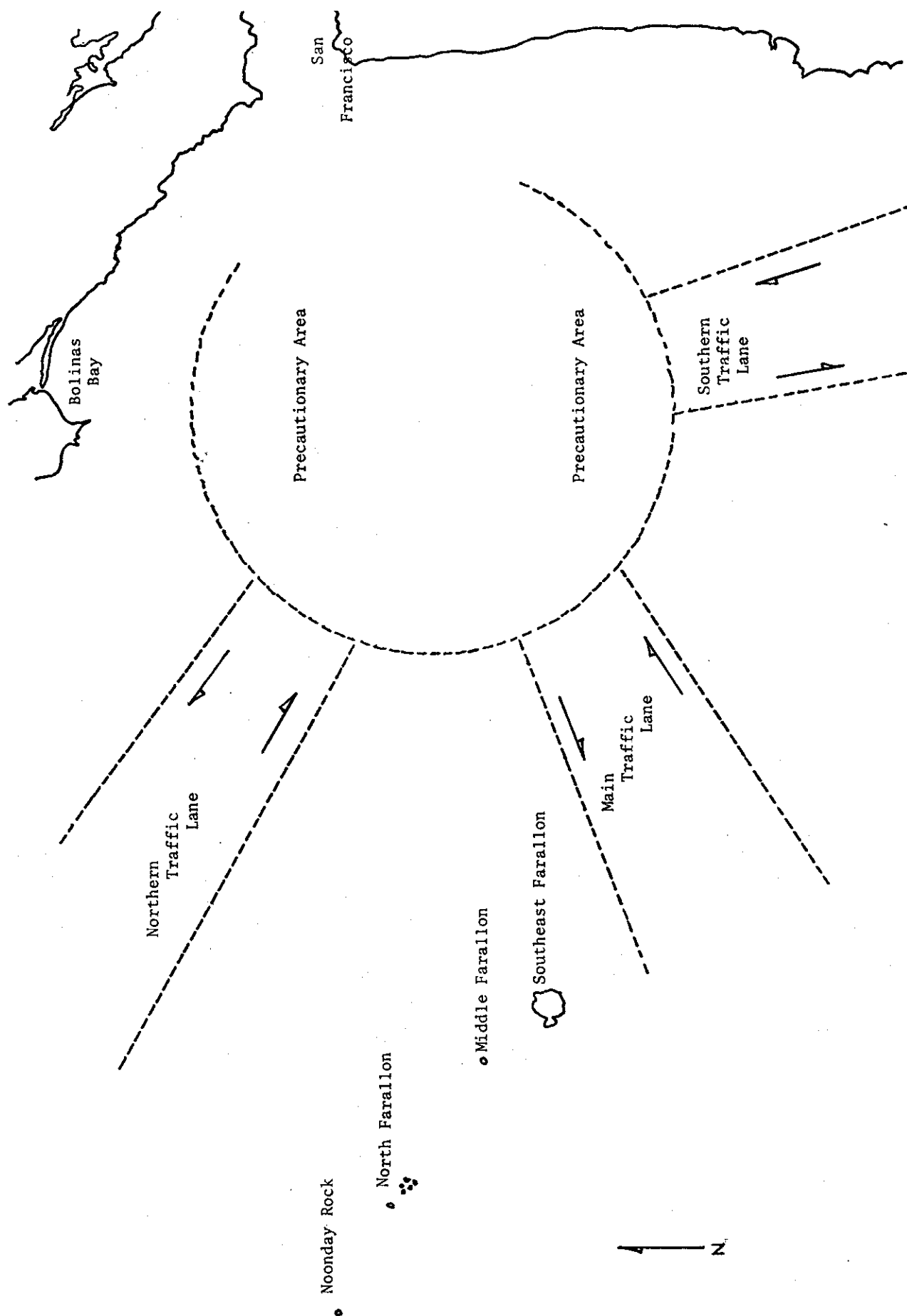


Figure 12. Gulf Of The Farallons Shipping Lanes.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

Municipal and Industrial Wastes: The only waste disposal on the island is untreated sewage from the two residence houses. The total number of people on the island rarely exceeds 12 and averages 2 to 5 so the volume of sewage is quite small. This sewage is discharged into an intertidal surge channel in front of the house. There is no visible evidence that this effluent affects the intertidal region as the zonation is similar to that of adjacent areas (for detail see Intertidal Biota description) and elephant seals frequent the small beach (Ron LeValley, PRBO, personal communication).

Dredge and Spoil Disposal: Since 1935, various materials have been dumped in the vicinity of the Farallon Islands. Most of this material has been dredge spoils. However, before 1972 when Federal Water Pollution Control Act regulations governing disposal went into effect, various types of materials were dumped; much of it at sites only vaguely specified as west of San Francisco (Winzler and Kelly, 1977). The types and quantities of materials dumped since 1935 include:

<u>Category</u>	<u>Period</u>	<u>Estimated Total</u>
refinery wastes	1966-1972	315 million gallons
acid wastes	1948-1971	240 million gallons
cannery wastes	1960-1972	246 thousand tons
radioactive wastes	1946-1968	44,563 containers
munitions	1968-1969	746 tons
dredge spoil	1935-1972	1 million cubic yards

(Table reproduced from Winzler and Kelly, 1977, data from MacFarlane, 1974)

Subsequent to 1972 apparently only two dump sites have been approved, neither of which is within a 1 mi. (1.6 km) radius of the Farallons. Both of these sites are for dredge spoils only. One site, located at 37°41'N, 123°75'W is about 4 mi. (6.4 km) southwest of Southeast Farallon and was used only in 1975 as a study site for the U.S. Army Corps of Engineers. The other site, located at 37°31'N, 122°59'W is about 11 mi. (18 km) south of Southeast Farallon Island and has been in use since its designation as SF-7 in 1973.

Ocean disposal of dredge spoils has been found to be a costly alternative to other methods of dredge disposal (i.e. dumping the spoils near the dredge site) and is only used when the heavy metal content of the spoils exceeds the limits allowed for disposal in San Francisco Bay. Apparently, for this reason, site SF-7 has only been used 2-3 times per year since its designation. During calendar year 1977 the site was used 3 times for an approximate total of 68,000 cubic yards (52,000 cubic meters) (John Adsit, COE, personal communication). The fate of dredge spoils dumped on the ocean floor is uncertain. Studies have indicated that, at least for short periods of time, the spoils are mounted on the bottom as a cohesive mass (John Sustar, COE, personal communication; Stephen Pace, MLML, personal communication), and it is believed that in the absence of strong currents there is little longterm movement.

Radioactive Wastes: Between 1946 and 1966 several sites within 4 to 14 mi. (6 to 23 km) of Southeast Farallon Island were used for disposal of radioactive waste materials. Review of the records for this period indicates that approximately 47,750 containers were dumped, mostly 55 gallon drums containing 'low level radiation' such as contaminated rubber gloves, rags, glass and liquid waste mixed into concrete (Joseph, et al., 1971). These containers were distributed over a wide area southwest of the island at depths ranging from 50 to 1,000 fathoms (300 to 6,000 ft.).

In 1974 and again in 1975 and 1977 Interstate Electronics Corporation, under contract with the Environmental Protection Agency, performed surveys of the dump sites, assessed the condition of the containers and collected

samples for radioanalysis. Underwater television and still photography indicated that approximately 25% of the containers were ruptured, either having imploded as a result of increasing hydrostatic pressure as they sank to the bottom or having corroded during the time since they were dumped. Baseline analyses of sediment core samples for plutonium (^{238}Pu and $^{239+240}\text{Pu}$) have yielded average fallout values varying between 4.5 and 18 pCi/kg dry weight in the top 5 cm of bottom sediment in regions between 35°-40° N latitude (Bowen, et al., in press). In sediments collected within a cluster of both intact and breached containers at the 900 meter Farallon dumpsite, the "level of $^{239+240}\text{Pu}$ contamination in surface sediments is shown to be 2 to 25 times higher than the maximum expected concentration that could have resulted from weapons testing fallout." (Dyer, 1976)

A more recent survey conducted by scientists from the Lawrence Livermore Laboratory (Noshkin, et al., 1978), however, concludes that total $^{239+240}\text{Pu}$ and ^{137}Cs in Farallon water columns and in fish and invertebrates from the disposal region are within global fallout levels. This study found ^{238}Pu concentrations exceeding anticipated fallout levels in bottom sediments of the 6,600 ft. (2,000 m) Farallon disposal site, and the authors dispute Dyer's (1976) method of assessing concentration levels. Resolution of this apparent controversy awaits the analyses of Dyer's more recent samples which were collected late in 1977.

Offshore Oil Development: The leasing of oil drilling sites is prohibited within 3 mi. (4.8 km) of the coastline. This would include a three mile radius around the Farallon Islands. Leasing of remaining open water area is conducted according to a leasing schedule established by the Bureau of Land Management Pacific Outer Continental Shelf Office.

The Outer Continental Shelf Lands Act Amendment established a 15 mi. (24 km) radius around Point Reyes in which drilling would be prohibited. An amount of money to be allocated to a 'clean up fund' in the event of an oil spill is part of this bill.

Vessel Discharge: The 1973 World Oil Pollution Act prohibits any bilge pumping within a 50 mi. (80 km) limit of all coast lines. This distance would include the Farallon Islands.

Nonpoint Sources

Oil Spills and Seeps: The United States Government prohibits any type of oil spill or seepage within 12 mi. (19 km) of land. The law includes fish oil and crude oil and its products and applies to ocean waters within a 12 mi. (19 km) radius of the Farallon Islands.

Records of oil spills on or in the vicinity of the Farallon Islands are contained in the Point Reyes Bird Observatory Farallon log book or can be supplied by the U.S. Coast Guard. Most of the incidents are concerned with oil soaked birds, and rarely is there any mention of oil slicks on nearshore waters or oil-covered rocks on the Farallon Islands. The U.S. Coast Guard documents open-water slicks within a 45 mi. (72 km) radius of the island. None of these slicks have reached the island. Occasionally operator-error in filling the diesel fuel containers on Southeast Farallon Island have caused small spills of fuel; in one instance, the generator began leaking, causing oil to flow over East Landing. See Table 12 for a more detailed account of the oil spills and slicks in the vicinity of the Farallon Islands for the period 1970 to early 1978.

Land Development: There are two houses and several other U.S. Coast Guard structures on Southeast Farallon Island; however, no new construction is planned.

Harbor Development: In March 1978 the U.S. Coast Guard placed a mooring buoy in Fiserhman's Bay, an otherwise unimproved anchorage.

Solid Waste Disposal: Burnable garbage is incinerated. Nonburnable material is carried off the island by boat while vegetable matter is composted.

Table 12. Summary of Oil Spill Information for
The Farallon Islands

Sources: Point Reyes Bird Observatory Farallon Log Records
and
U.S. Coast Guard Oil Spill Reports.

(PRBO Farallon logs report incidents of oiled birds
on the island, or slicks in adjacent waters; Coast
Guard information is for a 40 mile radius around
the island.)

<u>Date</u>	<u>Incident</u>	<u>Source of Information</u>
<u>1970</u>		
4 Feb	1 oiled ashy petrel	PRBO Log
16 Aug	oil in small coves on the north side of the island	PRBO Log
17 Aug	more oil still flowing around the island. Lots of dead algae and invertebrates	PRBO Log
18 Aug	oil in Breaker Cove	PRBO Log
19 Aug	1 oiled phalarope	PRBO Log
23 Aug	oil still in Breaker Cove	PRBO Log
27 Aug	1 oiled pigeon guillemot	PRBO Log
5 Nov	1 oiled Scoter	PRBO Log
11 Dec	elephant seals and driftwood have heavy oil spots; few common murres and gulls with oil also	PRBO Log
21 Dec	oil in water by north side of island	PRBO Log
<u>1971</u>		
13 Jan	1 oiled rhino auklet	PRBO Log
18 Jan	major oil spill under Golden Gate	news services
20 Jan	oiled birds: 111 murres, 4 western gulls, 5 glaucous-winged gulls	PRBO Log
21 Jan	oiled birds: 187 oiled murres, 1 western grebe, 1 white-winged scoter	PRBO Log
22 Jan	oiled birds: 127 murres, some dead, 1 western grebe, 1 white-winged scoter	PRBO Log
23 Jan	few oiled murres	PRBO Log
24 Jan	45 dead and oiled murres	PRBO Log
25 Jan	20% of murres with oil spots, 29 oiled murres around island	PRBO Log
26 Jan	20-25% of common murres around north landing with oil spots	PRBO Log
27 Jan	1 new oiled bird	PRBO Log
28 Jan	3 new oiled birds	PRBO Log
30 Jan	1 new oiled bird, tar around island	PRBO Log
1 Feb	1 elephant seal with oil on belly, oil in Fisherman's Bay	PRBO Log
2 Feb	more tar and straw in Fisherman's Bay	PRBO Log
14 Mar	2 birds with oiled faces	PRBO Log
29 Dec	1 oiled murre	PRBO Log

Table 12. Summary of Oil Spill Information for The Farallon Islands (cont'd)

<u>Date</u>	<u>Incident</u>	<u>Source of Information</u>
<u>1972</u>		
4 Jan	1 oiled murre	PRBO Log
18 Jan	1 oiled murre	PRBO Log
17 Sep	1 oiled western gull, 1 oiled western sandpiper	PRBO Log
18 Sep	1 oiled red phalarope	PRBO Log
19 Sep	1 oiled red phalarope, probably same as yesterday	PRBO Log
23 Nov	1 oiled murre in Breaker Bay	PRBO Log
7 Dec	1 oiled rhino auklet in Fisherman's Bay	PRBO Log
<u>1973</u>		
14 Jan	oil splattered on shore and on birds	PRBO Log
19 Jan	5 oiled murres	PRBO Log
26 Feb	oiled murre in Fisherman's Bay	PRBO Log
30 Mar	2 oiled murres	PRBO Log
5 May	1 oiled common murre	PRBO Log
10 May	1 oiled murre at East Landing	PRBO Log
16 May	1 oiled murre at East Landing, still alive	PRBO Log
7 Jun	gasoline at 38°02'N, 123°07'W, from gasket failure on a tank barge of 0-149 gross tons (amount of spill 1 gallon) near Pt. Reyes	Coast Guard
16 Jun	2 oiled guillemots and 1 oiled murre at East Landing, 1 oiled guillemot at North Landing	PRBO Log
17 Jun	3 oiled murres, 2 oiled guillemots	PRBO Log
18 Jun	5 oiled murres, 3 oiled guillemots	PRBO Log
21 Jun	large oil slicks 5-6 miles east of the island, many large globs of heavy oil closer to island, slick looks to be 1/2 to 3/4 mile long and 2,000-3,000 yards wide	PRBO Log
19 Sep	100+ gallons diesel fuel overflowed from tanks onto marine terrace during pumping, fuel allowed to drain downhill to boat	PRBO Log
31 Oct	again, overflow of diesel fuel during pumping	PRBO Log
12 Nov	20% of elephant seals, 1 common loon and many washed-up feathers show signs of oiling	PRBO Log
5 Dec	6 oiled murres	PRBO Log

Table 12. Summary of Oil Spill Information for the Farallon Islands (cont'd)

<u>Date</u>	<u>Incident</u>	<u>Source Information</u>
<u>1974</u>		
10 Jan	1 dead oiled ancient murrelet	PRBO Log
17 Jan	oil washed in as gobs of tar	PRBO Log
21 Jan	lots of oil washing in on North side, 1 oiled bird	PRBO Log
30 Mar	16 oiled murres	PRBO Log
4 Jun	1 oiled phalarope	PRBO Log
24 Jul	15 gallons of heavy crude oil spilled from a marine transportation facility at 38°01'N, 122°58'W (Drakes Bay) cause unknown	Coast Guard
30 Dec	1 oiled murre	PRBO Log
<u>1975</u>		
9 Mar	oiled birds, 7 murres and 1 auklet	PRBO Log
25 Mar	25 gallons of unidentified light oil spilled at 37°35'N, 123°16'W. Source and cause unknown	Coast Guard
18 Apr	150 gallons of waste oil intentionally discharged from tank cleaning or stripping at 37°25'N, 123°15'W. Source unknown	Coast Guard
14 May	side of generator smashed allowing oil to spill over edge of East Landing	PRBO Log
27 Jun	1 badly soaked murre, plus several others with oil spots. 1 oil covered guillemot egg	PRBO Log
28 Jun	5% of murres have oil spots. 3 murres and 2 guillemots hauled out on East Landing because they were badly oil soaked. 1 gull with smear	PRBO Log
2 Jul	oil soaked guillemot died	PRBO Log
3 Jul	oiled birds, 1 murre at East Landing, 1 rhino auklet at North Landing	PRBO Log
<u>1976</u>		
1 Feb	1 badly oiled murre	PRBO Log
17 Feb	1 black kittiwake oiled	PRBO Log
18 Feb	1 black kittiwake with oil on breast	PRBO Log
23 Feb	1 northern phalarope slightly oiled	PRBO Log
6 May	10 gallons of #5 fuel oil spilled from a dry cargoship at 38°00'N, 122°52'W. cause unknown	Coast Guard
16 May	1 oiled artic loon	PRBO Log
16 Aug	100 gallons of waste oil spilled, source and cause unknown. spilled at 37°46'N, 122°44'W	Coast Guard
15 Nov	1 oiled murre	PRBO Log
30 Nov	presence of oil drops in water (comprizing approximately 1 gallon	PRBO Log

Table 12. Summary of Oil Spill Information for the Farallon Islands (cont'd)

<u>Date</u>	<u>Incident</u>	<u>Source of Information</u>
<u>1977</u>		
11 Jan	1 oiled murre washed up in Log Channel	PRBO Log
14 Mar	unknown source, cause and amount of heavy diesel oil spilled at 37°30'N, 122°50'W	Coast Guard
20 Mar	1 oiled common murre	PRBO Log
22 Mar	1 oiled kittiwake	PRBO Log
28 Mar	1 oiled bird	PRBO Log
30 Apr	oil spill at East Landing, bilge pumping from fishing boat?	PRBO Log
22 Aug	1 gallon of gasoline spilled from an onshore bulk cargo transfer due to a transportation pipeline rupture or leak due to faulty materials at 37°55' N, 122°55'W	Coast Guard
13 Nov	1 oiled arctic loon	PRBO Log
<u>1978</u>		
7 Jan	12 oiled murres	PRBO Log
8 Jan	9 live, 1 dead oiled murres	PRBO Log
9 Jan	7 live, 1 dead oiled murres	PRBO Log
10 Jan	2 live oiled murres	PRBO Log
11 Jan	1 oiled murre, live	PRBO Log

might be desirable to provide added protection for nearshore water quality, after reviewing sources of water pollution affecting the ASBS. It is important that high water quality standards be met, as several rare and endangered species frequent the Farallons and adjacent waters in large numbers, and are affected directly or indirectly by water quality in the ASBS.

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APPENDIX 1

Attached aquatic plants found in the subtidal region of Farallon Islands.

CHLOROPHYTA

Codiales

Derbesia sp.

Codium setchellii Gardner

PHAEOPHYTA

Chordariales

Compsonema serpens Setchell & Gardner

Laminariales

Dictyoneurum californicum Ruprecht

Nereocystis luetkeana (Mertens) Postels & Ruprecht

RHODOPHYTA

Goniotrichales

Goniotrichum alsidii (Zanardini) Howe

Goniotrichopsis sublittoralis Smith

Bangiales

Erythrotrichia sp.

Porphyra sp.

Nemaliales

Acrochaetium spp.

Pterocladia caloglossoides (Howe) Dawson

APPENDIX 1 Continued

Cryptonemiales

- Peyssonellia meridionalis Hollenberg & Abbott ?
Melobesia marginata Setchell & Foslíe
Mesophyllum lamellatum (Setchell & Foslíe) Adey
Clathromorphum parcum (Setchell & Foslíe) Adey
Lithophyllum grumosum (Foslíe) Foslíe
Chiharaea bodegensis Johansen
Bossiella californica (Decaisne) Silva
Bossiella californica schmittii (Manza) Johansen
Bossiella plumosa (Manza) Silva
Bossiella corymbifera (Manza) Silva
Calliarthron cheilosporioides Manza
Calliarthron tuberculosum (Postels & Ruprecht) Dawson
Pugetia fragilissima Kylin
Callophyllis violacea J. Agardh ?
Choreocolax polysiphoniae Reinsch

Gigartinales

- Schizymenia epiphytica (Setchell & Lawson) Smith & Hollenberg
Opuntiella californica (Farlow) Kylin
Plocamium cartilagineum (Linnaeus) Dixon
Rhodoglossum californicum (J. Agardh) Abbott
Rhodoglossum sp.

Rhodymeniales

- Faucheia laciniata J. Agardh
Rhodymenia californica Kylin

APPENDIX 1 Continued

Ceramiales

Antithamnion defectum Kylin

Antithamnion dendroideum Smith & Hollenberg

Platythamnion villosum Kylin

Ceranium gardneri Kylin

Microcladia coulteri Harvey

Callithamnion biseriatum Kylin

Pleonosporium vancouverianum (J. Agardh) J. Agardh

Griffithsia pacifica Kylin

Tiffaniella snyderiae (Farlow) Abbott

Ptilothamnionopsis lejolisea (Farlow) Dixon

Branchioglossum woodii (J. Agardh) Kylin

Delesseria decipiens J. Agardh

Cryptopleura corallinara (Nott) Gardner

Botryoglossum farlowianum (J. Agardh) DeToni

Polysiphonia pacifica Hollenberg

Pterosiphonia dendroidea (Montagne) Falkenberg

Herposiphonia parva Hollenberg

Ceramiella sp. ?

PORIFERA (Cont'd)

DEMOSPONGIA (cont'd)

Tethya aurantia (Pallas, 1766)

Stelletta clarella de Laubenfels, 1930

CALCAREA

Leucosolenia eleanor Urban, 1905

Scypha sp.

Leucandra heathi Urban, 1905

Leucilla nuttingi (Urban, 1902)

CNIDARIA

HYDROZOA

Stylantheca porphyra Fisher, 1930

ANTHOZOA

Anthopleura elegantissima (Brandt, 1835)

Anthopleura xanthogrammica (Brandt, 1835)

Epiactis prolifera Verrill, 1869

Tealia crassicornis (Muller, 1776)

Tealia lofotensis (Danielssen, 1890)

Balanophyllia elegans Verrill, 1864

Corynactis californica Carlgren, 1936

ANNELIDA

POLYCHAETA

Halosydna brevisetosa Kinberg, 1855

Hesperonoe sp.

Pareuythoe californica (Johnson, 1897)

Nereis sp.

Nereis eakini Hartman, 1936

ANNELIDA (cont'd)

POLYCHAETA (cont'd)

Nereis grubei (Kinberg, 1866)

Nereis vexillosa Grube, 1851

Anaitides sp.

cf. Genetyllis castanea (Marenzeller, 1897)

Autolytus sp.

Trypanosyllis gemmipara Johnson, 1901

Typosyllis aciculata Treadwell, 1945

Arabella semimaculata (Moore, 1911)

Lumbrineris japonica (Marenzeller, 1897)

Lumbrineris zonata (Johnson, 1901)

Nothria stigmatis (Treadwell, 1922)

Polydora sp.

Polydora alloporis Light, 1970

Cirratulus sp.

Dodecaceria fewkesi Berkeley and Berkeley, 1954

Terebella californica Moore, 1904

Thelepus crispus Johnson, 1901

Salmacina tribranchiata (Moore, 1923)

Serpula vermicularis Linnaeus, 1767

Marphysa stylobranchiata Moore, 1909

APPENDIX 2 Continued

MOLLUSCA (Almost entirely from Lindberg & Carlton, MS)

POLYPLACOPHORA

- Cryptochiton stelleri (Middendorff, 1846)
- Cyanoplax hartwegii (Carpenter, 1855)
- Cyanoplax dentiens (Gould, 1846)
- Ischnochiton regularis (Carpenter, 1855)
- Lepidozona cooperi (Pilsbry, 1892)
- Lepidozona mertensii (Middendorff, 1846)
- Lepidozona lineata (Wood, 1815)
- Nuttalina californica (Reeve, 1847)
- Katharina tunicata (Wood, 1815)
- Mopalia ciliata (Sowerby, 1840)
- Mopalia lignosa (Gould, 1846)
- Mopalia muscosa (Gould, 1846)
- Mopalia hindsii (Reeve, 1847)
- Leptochiton internexus (Carpenter & Pilsbry, 1892)
- Chaetopleura gemma Dall, 1879

GASTROPODA

- Haliotis cracherodii Leach, 1814
- Haliotis kamtschatkana Jonas, 1845
- Haliotis rufescens Swainson, 1822
- Haliotis walallensis Stearns, 1899
- Sinezona rimuloides (Carpenter, 1865)
- Diodora arnoldi McLean, 1966
- Diodora aspera (Rathke, 1833)
- Megatebennus bimaculatus (Dall, 1871)
- Tectura rosacea (Carpenter, 1864)

APPENDIX 2 Continued

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

- Littorina scutulata Gould, 1849
Alvinia carpenteri (Weinkauff, 1885)
Alvinia compacta (Carpenter, 1864)
Alvinia dinora (Bartsch, 1917)
Alvinia purpurea (Dall, 1871)
Barleeia haliotiphila Carpenter, 1864
Barleeia subtenuis Carpenter, 1864
Mistostigma albidum (Carpenter, 1864)
Omalogyra sp.
Caecum californicum Dall, 1885
Fartulum occidentale Bartsch, 1920
Dendropoma lituella (Morch, 1861)
Petalconchus montereyensis Dall, 1919
Bittium eschrichtii (Middendorff, 1849)
Bittium purpureum (Carpenter, 1864)
Cerithiopsis carpenteri Bartsch, 1911
Epitonium tinctum (Carpenter, 1865)
Opalia wroblewskyi (Morch, 1875)
Balcis thersites (Carpenter, 1864)
Aclis shepardiana (Dall, 1919)
Hipponix cranioides Carpenter, 1864
Crepidatella lingulata (Gould, 1846)
Crepidula perforans (Valenciennes, 1846)

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

- Crepidula sp. cf. C. nummaria Gould, 1846
- Crepidula adunca Sowerby, 1825
- Velutina sp. cf. V. velutina (Muller, 1776)
- Trivia californiana (Gray, 1827)
- Ceratostoma foliatum (Gmelin, 1791)
- Ocenebra atropurpurea Carpenter, 1865
- Ocenebra interfossa Carpenter, 1864
- Ocenebra lurida (Middendorff, 1848)
- Nucella canaliculata (Duclos, 1832)
- Nucella emarginata (Deshayes, 1839)
- Alia carinata (Hinds, 1844)
- Mitrella tuberosa (Carpenter, 1864)
- Amphissa columbiana Dall, 1916
- Amphissa versicolor Dall, 1871
- Nassarius mendicus (Gould, 1850)
- Granulina margaritula (Carpenter, 1857)
- Cymakra aspera (Carpenter, 1864)
- Diaphana californica Dall, 1919
- Odostomia sp.
- Trimusculus reticulatus (Sowerby, 1835)
- Onchidella borealis Dall, 1871
- Rostanga pulchra MacFarland, 1905
- Archidoris montereyensis (Cooper, 1863)

APPENDIX 2 Continued

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

Anisodoris nobilis (MacFarland, 1905)

Diaulula sandiegensis (Cooper, 1862)

Cadlina luteomarginata MacFarland, 1966

Cadlina modesta MacFarland, 1966

Triopha catalinae (Cooper, 1863)

Hermisenda crassicornis (Eschscholtz, 1831)

BIVALVIA

Philobrya setosa (Carpenter, 1864)

Modiolus carpenteri Soot-Ryen, 1963

Mytilus californianus Conrad, 1837

Mytilus edulis Linnaeus, 1758

Musculus pygmaeus Glynn, 1964 ?

Hinnites giganteus (Gray, 1825)

Pododesmus cepio (Gray, 1850)

Diplodonta orbella (Gould, 1851)

Lasaea cistula Keen, 1938

Lasaea subviridus Sall, 1899

Kellia laperousii (Deshayes, 1839)

Chama arcana Bernard, 1976

Irus lamellifer (Conrad, 1837)

APPENDIX 2 Continued

MOLLUSCA (cont'd)

BIVALVIA (cont'd)

- Transennella tantilla (Gould, 1853)
- Protothaca staminea (Conrad, 1837)
- Petricola carditoides (Conrad, 1837)
- Milneria minima (Dall, 1871)
- Cryptomya californica (Conrad, 1837)
- Hiatella arctica (Linnaeus, 1767)
- Penitella conradi Valenciennes, 1846
- Entodesma saxicola (Baird, 1863)
- Mytilimeria nuttallii Conrad, 1837

CEPHALOPODA

- Octopus sp.

SIPUNCULIDA

- Phascolosoma agassizii Keferstein, 1867

ARTHROPODA

PYCNOGONIDA

- Achelia chelata (Hilton, 1939)
- Achelia spinoseta (Hilton, 1939)
- Lecythorhynchus hilgendorfi (Bohm, 1879)
- Nymphopsis spinosissima (Hall, 1912)
- Pycnogonum stearnsi Ives, 1892

ARTHROPODA (cont'd)

CRUSTACEA

- Pollicipes polymerus Sowerby, 1833
- Balanus cariosus (Pallas, 1788)
- Balanus nubilus Darwin, 1854
- Acanthomysis sp.
- Anatanaïs normani (Richardson, 1905)
- Paranthura elegans Menzies, 1951
- Exosphaeroma inornata Dow, 1958
- Idotea fewkesi Richardson, 1905
- Idotea schmitti (Menzies, 1950)
- Idotea stenops (Benedict, 1898)
- Idotea urotoma Stimpson, 1864
- Idotea wosnesenskii (Brandt, 1851)
- Ianiropsis kincaidi derjugini Gurjanova, 1933
- Cirolana harfordi (Lockington, 1877)
- Limnoria algarum Menzies, 1957
- Ligia pallasii Brandt, 1883
- Littorophiloscia richardsonae (Holmes and Gray, 1909)
- Paradynoides benedicti (Richardson, 1899)
- Porcellio americanus Arcangeli, 1932
- Oligochinus lighti Barnard, 1969
- Elasmopus serricatus Barnard, 1969
- Hyale cf. H. grandicornis californica Barnard, 1969
- Hyale sp.
- Allorchestes anceps (Barnard, 1969)
- Parallorchestes ochotensis (Brandt, 1851)

ARTHROPODA (cont'd)

CRUSTACEA (cont'd)

Parallorchestes sp.

Melita californica Alderman, 1936

Polycheria osborni Calman, 1898

Metacaprella aff. M. anomala (Mayer, 1903)

Alpheus dentipes Guerin, 1832

Hapalogaster cavicauda Stimpson, 1859

Oedignathus inermis (Stimpson, 1860)

Pagurus hirsutiusculus (Dana, 1851)

Petrolisthes cinctipes (Randall, 1839)

Loxorhynchus crispatus (Stimpson, 1857)

Pugettia gracilis Dana, 1851

Pugettia producta (Randall, 1839)

Scyra acutifrons Dana, 1861

Pachygrapsus crassipes Randall, 1839

Fabia subquadrata Dana, 1851

Lophopanopeus leucomanus heathii Rathbun, 1900

ECHINODERMATA

ASTEROIDEA

Patiria miniata (Brandt, 1835)

Dermasterias imbricata (Grube, 1857)

Leptasterias sp.

Piaster ochraceus (Brandt, 1835)

Pycnopodia helianthoides (Brandt, 1835)

APPENDIX 2 Continued

ECHINODERMATA (cont'd)

OPHIUROIDEA

- Ophiopteris papillosa (Lyman, 1875)
- Ophioplocus esmarki Lyman, 1874
- Amphiodia occidentalis (Lyman, 1860)
- Amphipholis squamata (Delle Chiaje, 1829)
- Ophiopholis aculeata forma kennerlyi (Lyman, 1860)
- Ophiothrix spiculata LeConte, 1851

ECHINOIDEA

- Strongylocentrotus franciscanus (Agassiz, 1863)
- Strongylocentrotus purpuratus (Stimpson, 1857)

HOLOTHUROIDEA

- Cucumaria curata Cowles, 1907

CHORDATA

UROCHORDATA

ASCIDIACEA

- Didemnum carnulentum Ritter and Forsyth, 1917

APPENDIX 2 Continued

Attached aquatic plants - This list is compiled from the ERC collections and from the collection reported by Blankinship (in Blankinship & Keeler, 1892).

Chlorophyta

Ulotrichales

Ulva lactuca Linnaeus

Enteromorpha compressa (Linnaeus) Greville

Enteromorpha clathrata (Roth) Greville

Prasiolales

Prasiola meridionalis Setchell & Gardner

Cladophorales

Cladophora columbiana Collins

Cladophora graminea Collins

Codiales

Bryopsis corticulans Setchell

Codium fragile (Suringar) Hariot

Phaeophyta

Chordariales

Leathesia difformis (Linnaeus) Areschoug

Analipus japonicus (Harvey) Wynne

Dictyosiphonales

Coilodesme californica (Ruprecht) Kjellman

Desmarestiales

Desmarestia ligulata (Lightfoot) Lamouroux

Laminariales

Laminaria dentigera Kjellman

APPENDIX 2 Continued

Egregia menziesii (Turner) Areschoug

Pterygophora californica Ruprecht

Macrocystis pyrifera (Linnaeus) C. Agardh

Nereocystis luetkeana (Mertens) Postel & Ruprecht

Alaria marginata Postels & Ruprecht

Costaria costata (C. Agardh) Saunders

Fucales

Fucus distichus edentatus (de la Pylaie) Powell

Pelvetia fastigiata (J. Agardh) De Toni

Cystoseira osmundacea (Menxies) C. Agardh

Rhodophyta

Bangiales

Porphyra perforata J. Agardh

Porphyra nereocystis Anderson

Smithora naiadum (Anderson) Hollenberg

Nemaliales

Gelidium purpurascens Gardner

Gelidium robustum (Gardner) Hollenberg & Abbott

Rhodochorton purpureum (Lightfoot) Rosenvinge

Cryptonemiales

Pikea californica Harvey

Grateloupia doryphora (Montagne) Howe

Farlowia compressa J. Agardh

Endocladia muricata (Postels & Ruprecht) J. Agardh

Corallina officinalis var. chilensis (Decaisne) Kützinger

Calliarthron cheilosporioides Manza

Melobesia mediocris (Foslie) Setchell & Mason

APPENDIX 2 Continued

Bossiella californica (Decaisne) Silva

Erythrophyllum delesserioides J. Agardh

Prionitis lanceolata Harvey

Prionitis lyallii Harvey

Prionitis linearis Kylin

Callophyllis flabellulata Harvey

Callophyllis obtusifolia J. Agardh

Callophyllis violacea J. Agardh

Gigartinales

Gigartina corymbifera (Kützinger) J. Agardh

Gigartina leptorhynchos J. Agardh

Gigartina papillata (C. Agardh) J. Agardh

Gigartina canaliculata Harvey

Gigartina exasperata Harvey & Bailey

Iridaea flaccida (Setchell & Gardner) Hollenberg & Abbott

Iridaea heterocarpa Postels & Ruprecht

Iridaea cordata var. splendens (Setchell & Gardner) Abbott

Gymnogongrus linearis (Turner) J. Agardh

Gracilaria sjoestedtii Kylin

Plocamium cartilagineum (Linnaeus) Dixon

Plocamium violaceum Farlow

Rhodymeniales

Rhodymenia pacifica Kylin

Gastroclonium coulteri (Harvey) Kylin

Ceramiales

Ceramium gardneri Kylin

Ceramium pacificum (Collins) Kylin

APPENDIX 2 Continued

Centroceras clavulatum (C. Agardh) Montagne

Microcladia coulteri Harvey

Microcladia borealis Ruprecht

Ptilota filicina (Farlow) J. Agardh

Neoptilota densa (C. Agardh) Kylin

Hymenema multiloba (J. Agardh) Kylin

Polyneura latissima (Harvey) Kylin

Botryoglossum ruprechtianum (J. Agardh) DeToni

Botryoglossum farlowianum (J. Agardh) DeToni

Cryptopleura violacea (J. Agardh) Kylin

Nienburgia andersoniana (J. Agardh) Kylin

Odonthalia floccosa (Esper) Falkenberg

Pterosiphonia baileyi (Harvey) Falkenberg

Pterosiphonia dendroidea (Montagne) Falkenberg

Pterochondria woodii (Harvey) Hollenberg

Laurencia spectabilis Postels & Ruprecht

Anthophyta

Monocotylendoneae

Phyllospadix torreyi Watson

APPENDIX 3

Species list of plants found on Southeast Farallon Island. *

BRYOPHYTA

Funaria hygrometrica Sibthorp. Abundant in 1892.

CONIFEROPHYTA

*Cupressus macrocarpa Hartweg. MONTEREY CYPRESS. Two trees about 25 feet tall grow next to the Coast Guard house. Blankinship reported no trees on the island in 1892. Ray (1934) mentioned a grove of 20 Monterey cypresses in a protected situation. Ornduff failed to mention the trees and Coulter gives the location of the old grove as near the fog horn.

*Pinus radiata D. Don. MONTEREY PINE. One tree east of the power house. The tree is only about 10 feet tall but its branches extend radially to a radius of about 7 feet.

ANTHOPHYTA

Dicotyledoneae

Amsinckia spectabilis Fischer & Meyer. Found sparsely in the south and southeast portions along the tram tracks and among the foundations. 0

*Anagallis arvensis Linnaeus. Along the tram tracks and near East Landing. B, 0

Calandrinia ciliata (Ruiz & Pavon) Candolle var. menziesii (W.J. Hooker) Macbride. RED MAIDS. Along the tram tracks.

*Chenopodium murale Linnaeus. Common along tram tracks and sidewalks in southeast portion. B?, 0?

*Cirsium vulgare (Savi) Tenore. BULL THISTLE. Around carpentry shop.

Claytonia perfoliata Donn [= Montia perfoliata (Donn) Howell].

MINER'S LETTUCE. Common along tram tracks. B, 0

*Coronopus didymus (Linnaeus) Smith. One specimen found in front of the living quarters.

APPENDIX 3 Continued

- *Cotula australis (Sieber) J.D. Hooker. Common along tram tracks. 0
- Crassula erecta (W.J. Hooker & Arnott) Berger [= Tillaea erecta H. & A.]. PIGMY WEED. Found with Plagiobothrys reticulatus where the soil is fine, gravelly, and firm, around the living quarters and in the southeast and east parts of the island. B,0
- *Cymbalaria muralis J. Gaertner, Meyer & Scherb. KENILWORTH IVY. One patch at back door of Coast Guard house.
- Erigeron glaucus Ker-Gawler. SEASIDE DAISY. Found sparsely on all the rocky cliffs on the island. B
- *Erodium cicutarium (Linnaeus) L'Heritier. Found along tram tracks. B,0
- *Erodium moschatum (Linnaeus) L'Heritier. Found along tram tracks.
- Heloptropium curassavicum Linnaeus var. oculatum (Heller) Johnston. Small patch in front of the carpentry shop.
- Lasthenia minor (Candolle) Ornduff ssp. maritima (Gary) Ornduff [= Baeria m. (DC) Ferris ssp. m. (Gray) Ferris]. FARALLON WEED. Most abundant plant on the island found sparsely among rocks but thickly in the open areas of the north and south parts of the island. B,0
- *Lavatera arborea Linnaeus. East and southeast part of the island.
- Plagiobothrys reticulatus (Piper) Johnston var. rossianorum. Johnston. Common around living quarters and power house growing with Crassula erecta. 0
- *Senecio vulgaris Linnaeus. COMMON GROUNDSEL. Common in the southeast part of the island along the tram tracks, sidewalks and among foundations.
- *Sonchus asper Linnaeus. Also found along tram tracks, sidewalks and among foundations. B,0
- *Sonchus oleraceus Linnaeus. Same distribution as S. asper.

APPENDIX 3 Continued

*Spargularia macrotheca (Hornemann) Herhold. Common among rocks where the soil is thin in the north and southwest, sparsely in the southeast. 0

Spargularia marina (Linnaeus) Grisebach. Common in thin soil among rocks in the south and southeast parts of the island. B?,0?

*Stellaria media (Linnaeus) Villars. COMMON CHICKWEED. Found along the tram tracks, around the carpentry shop and above North Landing. B

*Tetragonia tetragonoides (Pallas) Ktze. One large patch located between living quarters.

Trifolium variegatum Nuttall. Located between living quarters and power house.

*Urtica urens Linnaeus. DWARF NETTLE. Found around living quarters and east of the power house. 0

Monocotyledoneae

*Bromus diandrus Roth [=B. rigidus Roth]. RIPGUT GRASS. Found in small clumps in the south and southeast portions of the island.

*Hordeum leporinum Link. BARLEY. Common in south and southeast portions of island growing with Vulpia bromoides. B,0

*Poa annua Linnaeus. ANNUAL BLUEGRASS. Found sparsely where the soil is thin, fine and gravelly around the living quarters and in the south and southeast parts of the island. B,0

*Polypogon monspeliensis (Linnaeus) Desfontaines. Growing in thin soil on path to the lighthouse and in the southeast part of the island. B?,0

APPENDIX 3 Continued

*Vulpia bromoides (Linnaeus) S.F. Gray [= Festuca dertonensis

(All.) Asch. & Graebn.]. Grows commonly and thickly with

Hordeum leporinum. B?,0

*Zantedeschia aethiopica (Linnaeus) Sprengel. CALLA LILLY.

Among foundations in the southeast and in front of the
carpentry shop.

Lichens

Buellia petraea (Flat., Koerb.) Tuck.? On rocks.

Placodium sp. On rocks.

Theloschistes lychnus (Nyl.) Tuck. var. pygmaeus Fr. On high rocks.

*The list of plants is that of Coulter (1972), except for lichens and Bryophyta which are from Blankinship (in Blankinship & Keeler, 1892). The list pertains only to the main portion of Southeast Farallon Island, not to West End or any of the surrounding islets or rocks, nor to Middle or North Farallons. The vegetation of these inaccessible areas is sparse and probably similar to that of the rocky cliffs on the main island. The annotations are mostly those of Coulter (op. cit.) as is the nomenclature; the name used by Munz and Keck (1959) is in synonymy where it differs. If the species was also reported by Blankinship (op. cit.) or Ornduff (1961) the entry is followed by "B" or "O" respectively. An asterisk denotes an introduced species.